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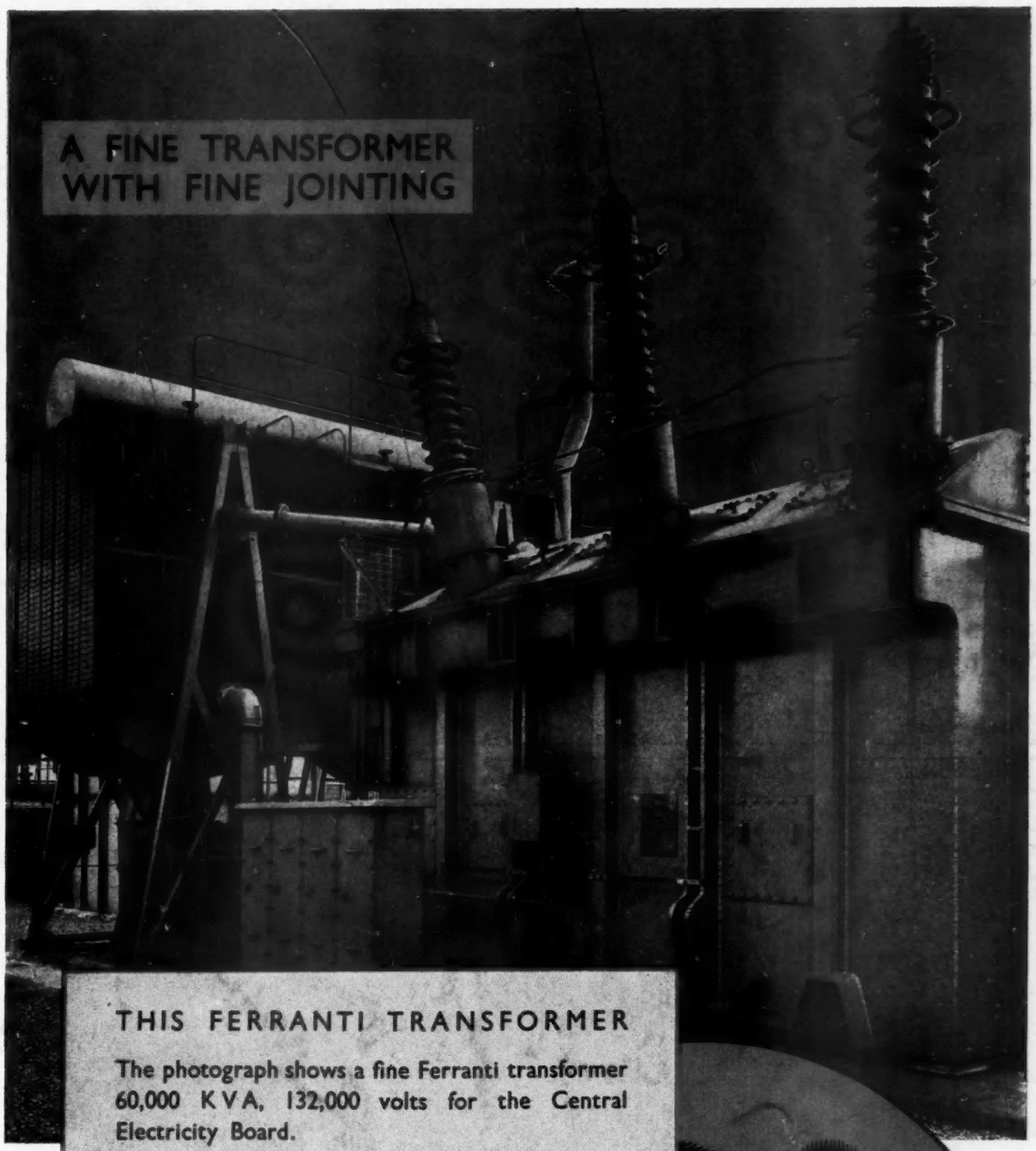

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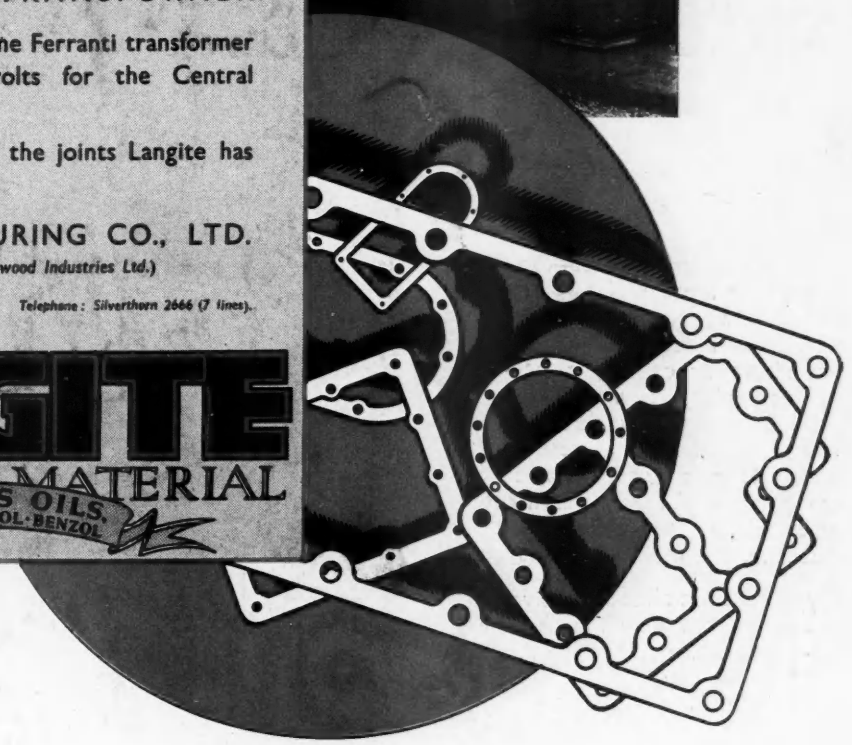

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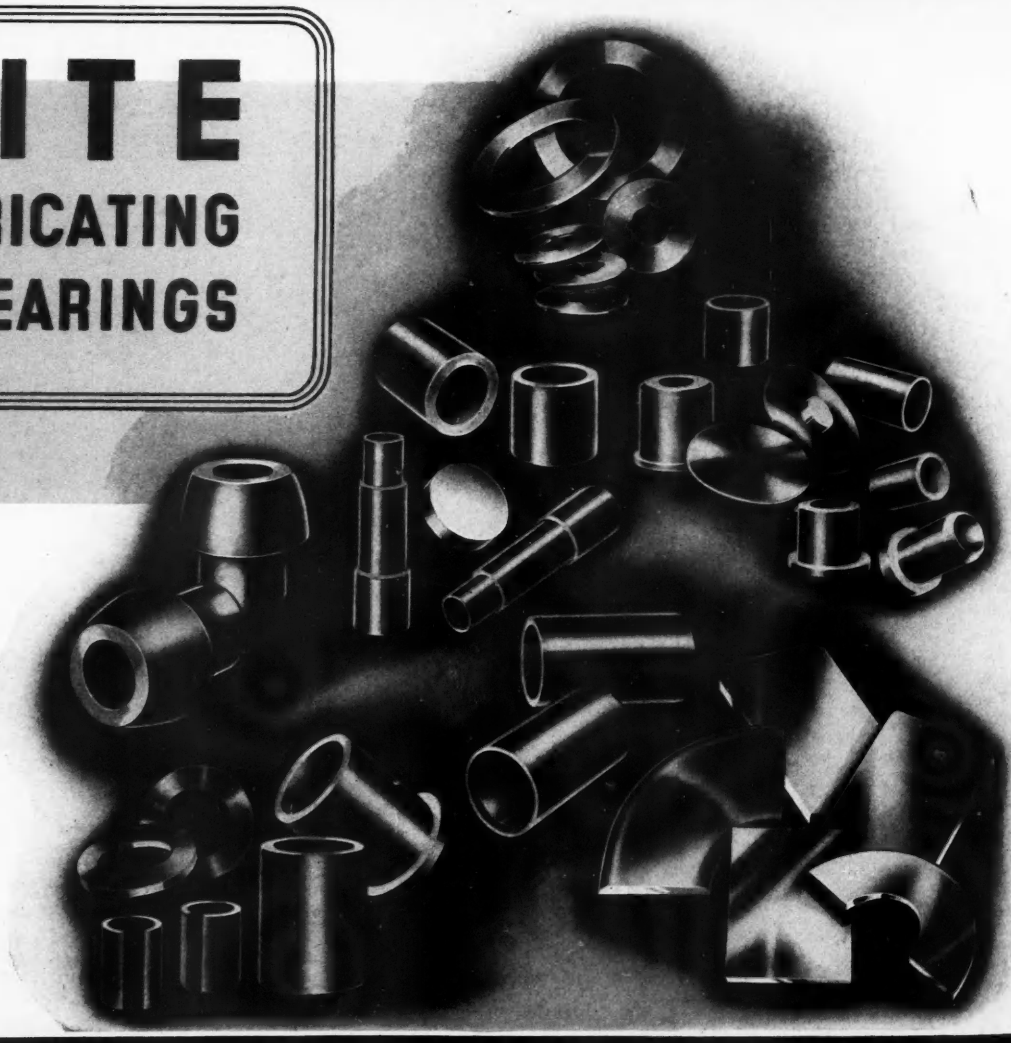

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Estimates for Navy, Army, and Air Services

THE Lords Commissioners of His Majesty's Treasury have had under consideration the question in what form Parliament shall be asked to make provision in 1940, and for the period of the war, for Navy, Army, and Air services, for the Ministry of Supply, and for certain other services connected with the war. They are satisfied that it is neither practicable nor desirable to present to Parliament detailed estimates purporting to cover the whole cost of these services. It would not be practicable inasmuch as that part of the expenditure on these services directly related to the war must clearly depend on the course and progress of the war in circumstances which cannot be foreseen; equally it would not be desirable in the public interest to disclose through the estimates the nature and extent of the war effort as envisaged at the time the estimates were published. The question remains whether estimates could nevertheless be presented on a basis which would at least cover the normal peace provision, leaving any excess to be met from votes of credit. My Lords have come to the conclusion that this should not be attempted. It would be impossible in the circumstances of the last few years to establish what should be regarded as the normal provision and there would be little value or meaning in presenting estimates based on the course of expenditure immediately before the outbreak of war. Moreover such normal provision would, in many cases, include services which have lapsed or been greatly curtailed on the outbreak of war. There appears therefore to their Lordships to be no satisfactory alternative to dispensing for the duration of the war with estimates for these services in the normal form and to making provision for this expenditure under votes of credit.

Electricity Undertakings and Finance

FROM representations which have been received by the Electricity Commissioners, it appears that in a number of cases circulars issued by H.M. Treasury in the latter part of 1939 concerning the raising of money for capital purposes have been construed by electricity undertakers as imposing, in effect, an embargo upon the provision of supplies of electricity to any new consumers except where the supplies are directly required for war work. It has now been confirmed by H.M. Treasury, with whom the Commissioners have been in communication on the matter, that it was not the intention of the circulars to prohibit public utility undertakers from complying with any statutory obligations, or from meeting so far as practicable the reasonable domestic and commercial demands of the community so long as the necessary mains, service materials and consumers' apparatus are readily available. On the other hand there can be no question of undertakers endeavouring under war conditions to proceed with the development of their undertakings to the same extent as under normal conditions, or to provide as complete facilities as formerly to consumers in the way of assisted wiring and the hire or hire purchase of apparatus. Undertakers must continue to draw a distinction between works and facilities which are for meeting necessary domestic and commercial requirements and those which, although desirable, could be postponed without undue hardship. Care should also be taken by the undertakers to avoid any undue depletion of their spare stocks of cables, transformers, &c., held in reserve as an air raid precautionary measure in view of the increasing difficulties which may be expected in replenishing such stocks. Any work on change-over from direct to alternating current should be limited to the minimum necessary for avoiding expenditure on extensions of converting plant and direct current mains.

Aircraft of 1914 and 1939

THE contrast between the aircraft with which we began the war in 1914 and those taking part in the initial stages of the present war is interesting and significant. In 1914, one of the first British aircraft types to take part in the operations on the Western Front was the B.E.2. This class of aircraft was designed at the Royal Aircraft Factory at Farnborough. It was originally, as its initials indicate, an experimental design embodying certain features characteristic of Mons. Blériot's practice. There were other designs—such as the F.E's, or Farman Experimental—which were produced at the same time for the purpose of instituting a comparative study—but none was as successful as the B.E. type. The B.E. 2 had a 70 H.P. Renault engine, which gave it a top speed of 70 m.p.h. and a rate of climb of about 360ft. per minute. With it Captain de Havilland set up a height record of 10,560ft., and on another occasion Captain Longcroft flew a B.E.2 machine from Montrose to Farnborough, a distance of 450 miles, in a flying time of 7 hours 40 mins., then considered a remarkable performance. The offensive armament of the machine consisted of nothing more than a rifle, revolver, or shot gun. To-day the Hawker "Hurricane," which, with the Vickers "Spitfire," has played a conspicuous part in the air fighting of the past six months, has a speed roughly five times as great as that of the B.E.2, a service ceiling more than thrice the altitude reached by Captain de Havilland, a rate of climb seven times as fast, and an engine fifteen times as powerful. Its armament consists of eight Browning guns mounted in the wings with a combined fire power of about 9000 rounds a minute.

Lancashire Electricity

ADDRESSING an ordinary general meeting of the Lancashire Electric Light and Power Company, Ltd., on February 22nd, Mr. George Balfour gave the following particulars of the service rendered by the company's power stations during the financial year. Although the loadings were less favourable than in the preceding year, he was able to report that the overall combined efficiency of the company's stations was a little higher, having risen from 24·24 per cent. to 24·62 per cent. The maximum loads on the company's stations, including the Central Electricity Board Supply, were as follows:—Kearsley station was 161,240 kW, an increase of 16,440 kW over 1938–39. The other two stations, Radcliffe and Padiham, carried about the same loads as in the preceding year, Radcliffe carrying a maximum of 42,578 kW and Padiham 18,486 kW. The simultaneous maximum load on all stations combined was 211,449 kW an increase of some 29,000 kW. The units sold to consumers were approximately 563 million, compared with 511¼ million in 1938–39, an increase of over 51 million units, and in addition nearly 300 million units were exported to the Central Electricity Board, an increase in exported units of some 34 million units over the preceding year. Mr. Balfour pointed out that war conditions have affected electricity supply undertakings in a widely varying degree. In some areas output has declined as much as 41 per cent., and the effect on the revenue of those companies has, obviously, been serious. The Lancashire Electric Light and Power Company was fortunate in having a diversified class of consumer and operating in a territory so geographically situated that it had not had to increase its charges.

American Ships Transferred to Belgium

SOME particulars of the new company which has been formed in Belgium to acquire the eight American liners, permission for the transfer of which has been given by the United States Maritime Commission, are given in a recent report of the Antwerp correspondent of the *Journal of Commerce*. It is to be known as the Sociéte Maritime Anversoise S.A., with an initial capital of 500,000 Belgian francs divided into fifty shares of 10,000 francs each, and of them the managing concern of the company is to take twenty-three shares and the United States Lines sixteen shares. The vessels concerned are the "President Harding," of 13,869 tons gross, "American Banker," "American Merchant," "American Shipper," "American Farmer," "American Trader," each of 7430 tons gross, the "American Importer" of 7590 tons gross, and the "American Traveller" of 7555 tons gross. All of the ships were built in the United States in 1920–21, and their purchase price is stated to be in the region of four million dollars for the eight ships. It is understood that the "President Harding" will be renamed "Ville de Bruxelles" and the other ships will also bear the names of Belgian cities, for example, "Ville de Bruges," "Ville de Hasselt," "Ville de Mons," and "Ville de Namur." It has not yet been stated officially on which route the transferred ships will be employed, but according to strong rumour the new company will take over the Antwerp–New York service of the Cie. Maritime Belge S.A. in order that other ships owned by the line may be released for other purposes. The new company will be managed by the Agence Maritime Internationale S.A. and its share capital will be gradually increased. As the capital is being provided by the shareholders, the Belgian State Maritime Fund will not intervene.

The Coal Export Trade

AT the general meeting of the Bolsover Colliery Company, Ltd., the chairman, Mr, N. B. Brooks, made some interesting remarks in respect of the coal export trade of the country. He reminded the meeting that a great deal had been said in recent months about the vital importance of increasing the export trade of the country. The large quantity of imports which will be required for the prosecution of the war makes the question of foreign exchange an increasingly important factor and the existing financial circumstances make it imperative that every possible effort be made to increase exports. He described how for a number of years prior to the outbreak of this war Germany had been building up a constantly increasing trade in the export of coal. In order to acquire more and more foreign trade she introduced two forms of subsidy; the first was provided out of a levy on her own internal consumption, and the second was a direct subsidy by the Government. Both of these subsidies were provided out of internal currency, and sales abroad enabled her to obtain credits for the purchase of those commodities which she was unable to produce at home. Mr. Brooks said that the coal industry could make an important contribution in this respect, and it was realised that every possible endeavour should be made to recover the trade which had been lost in former years as a result of subsidised competition. A considerable leeway had to be made up, and attention was drawn to the fact that whereas in 1913 the coal exports amounted to seventy-three and a half million tons, they had diminished to only thirty-six millions in 1938, with the exception of 1923 when eighty million tons of coal were exported.

Railways and Suburban Population

AN enquiry recently completed by the London Passenger Transport Board has shown the remarkable extent to which suburban population increases with the improvement of transport facilities. This fact is particularly evident on the Metropolitan line which passes through thirteen administrative areas. In the seven years from 1931 to 1938, the population in these areas increased by 231,700 to 958,700 or 32 per cent. The largest increase of population occurred on the Uxbridge line between West Harrow and Uxbridge, where it nearly doubled; between Preston Road and Harrow-on-the-Hill it increased by 88 per cent.; and between Kingsbury and Stanmore by 86 per cent. The growth of travel has been more rapid than the growth of population, the number of tickets purchased at Metropolitan stations increasing from nearly twenty-five and a half millions in 1933 to nearly thirty-eight and a half millions in 1938. When the passengers who took tickets at other Metropolitan stations are taken into consideration it is shown that nearly fifty-three and a half million people used the line in 1938. This growth of population and travel has been provided for by increasing the facilities for travelling by the Board. In 1933 the running of the Piccadilly trains was extended to Uxbridge, and in 1935 the Board co-operated with the main line companies in a programme of improvements. Before the establishment of the Board about 680 trains passed through Wembley Park in a normal day and the present number of 843 is evidence of the increase in travelling facilities which has been made possible only by the programme of improvements now in hand. When the fact that as many as 48 trains an hour leave Wembley Park for Baker Street, and the City is considered, it will be appreciated that great efforts have been made by the Board to maintain a high standard of travelling facilities.

War at Sea

IN presenting the Naval Estimates in the House of Commons on Tuesday, February 28th, Mr. Churchill, First Lord of the Admiralty, outlined Britain's supremacy in the war at sea. Referring to the construction and destruction of U-boats, he said that he believed it was safe to say that by the end of 1939 the Germans had lost from all causes at least half the U-boat fleet with which they had begun the war. If we put that fleet at about 70, that would leave some 35. On the other hand, he was in error some months ago when he told the House that the rate of new building of U-boats must be counted at two per week. That, and even more, might be true in the future; but it was not true up to the end of 1939. He doubted very much whether even 10 U-boats had come into action during that period. Thus the enemy ended the year with about 45 U-boats, of which probably not more than 10 were working at any one time. That figure must be compared with the figure of 60, all operating together, which on three occasions marked the peak which we wore down and broke in 1917. With regard to mastering the magnetic mine, he said that its use presented an additional complication. There was nothing new or novel about it, though mechanically it was very nicely made. He felt entitled to say that we felt our way to mastering the magnetic mine and other variants of the same idea. Mr. Churchill then dealt with the question of the big battleships, which, he said, some people thought were no use at all, "only anxieties at sea and a useless burden in port." That, he said, was a very superficial view. If we had not got at the present time an unquestioned superiority in battleships, the German heavy cruisers would come out into the Atlantic Ocean without fear of being brought to account. They might make temporary bases in many distant quarters of the globe. He then went on to say that since the "Royal Oak" was sunk we had not made use of Scapa Flow, which was, of course, our best strategic base. He recalled that when he was last at the Admiralty a regular stream of lame ducks was expected from the Fleet to the dockyards. But now the ships seemed to steam on for ever. That reflected the very greatest credit on the engineering branch of the Royal Navy.

G

New York Municipal Airport

No. II

(*Continued from page* 176, *Feb.* 23*rd*)

THE marine terminal building at the seaplane base is a two-storey circular structure, 144ft. in diameter, with an inside rotunda 74ft. 10in. in diameter. Two rectangular wings, each 54ft. by 45ft. project from the northern wall of the building—one toward the north-west and the other toward the north-east. The latter, which contains waiting rooms, connects with a covered way that leads to a ramp contiguous with the landing float in Bowery Bay, where the passengers board or leave the seaplane. A newly arrived seaplane, after discharging, will taxi over to a nearby runway extending out into the river and reaching down to the bottom. It is by this submerged ramp that the seaplane is moved up on to the shore and then shifted to the marine terminal hangar. The ramp has a wooden deck and the structure is supported on steel piles. A standard-gauge railway track is laid on the deck and extends into the bay to the underwater end of the ramp. The beaching gear, or dolly, which carries the aircraft travels on these rails during landing and launching. The beaching gear is 23ft. long and 14ft. wide, and has an average height of 6ft. It weighs about 30,000 pounds and is hauled by winch and by tractor. It operates as follows :—It is floated out to where the aircraft is moored in front of the ramp where its buoyancy is reduced as near to zero as possible by letting in water. The cradle is then pushed under the seaplane by the beaching crew and manœuvred into the required position, where it is fastened to attachments on the bottom of the seaplane and then pulled up the ramp until the wheels of the beaching gear make contact. The gear is then connected to the railway truck, and the whole is pulled up by a winch to the head of the ramp, where a tractor is hooked to the truck to move the assembly into the hangar over the tracks that branch out to the doors of the hangar. A group of movable workstands is used to service the ships, each of which is equipped with telephones for vocal contact with anyone throughout the hangar.

The marine terminal hangar is a five-sided building with two adjoining open sides, facing north-west and south-west respectively, each 204ft. 4in. wide, and a north and a south opening each 169ft. 7in. wide. The fifth side, the one facing the plaza, is 354ft. long. Each of the four openings is covered by electrically operated doors similar to those provided for the landplane hangars. Each doorway is 40ft. high and practically the full width of the side. The doors can be opened by electric power in 40 seconds, and can be raised by hand in a little longer time. The roof of the hangar is supported by an unusual system of trusses that radiate from a single pillar in the centre of the plaza side of the building. This arrangement obviates the use of other interior supports for the roof, and leaves the entire inside of the hangar free from any floor obstruction. If necessary, it will be possible, merely by extending the radiating trusses, to expand the roof system and to enlarge the floor space and the width of the different doorways. This provision has been made in order to accommodate trans-oceanic aircraft of greater size than those now in service. The overall dimensions of the marine terminal hangar are 300ft. by 354ft. in plan and 45ft. high from floor to trusses.

The side of the marine terminal hangar which faces the plaza is devoted to offices, accommodation for pilots and others, and shops. The present hangar is large enough to hold and to service five seaplanes at one time.

The marine terminal building is, in effect, a port of entry and it contains all essential offices and accommodation for that service. To that end it includes offices for custom inspectors, immigration inspectors, public-health service, separate baggage rooms for incoming and outgoing luggage, waiting rooms, and a lunch room. On the roof of the building, 48ft. above ground, there is an operating tower and all essential equipment for upper-air observation, for the Weather Bureau service, and for the radio service. The master plan provides for a second marine terminal hangar, of dimensions similar to the existing structure. This building will be situated to the south-west of the present hangar, and would use the same ramp and field service.

Petrol is delivered to the airport by tankers which discharge directly into tanks, by pipe lines leading to a storage building, near the water-front bulkhead. There are eighteen 20,000-gal. storage tanks with the necessary pumps, foamite, and loading apparatus. The petrol is distributed to the Pan-American Airways hangar by pipe line, but by truck to the eastern group of the landplane hangars. The American Airlines has a separate petrol-storage building to the west of its hangars, and in its storage building there are seven 15,000-gal. tanks, with all the auxiliary equipment. The tanks receive their petrol from Bowery Bay through a connecting pipe-line system.

To a pilot of an approaching aircraft, the airport at night will appear generally darkened, except at the edge of the field. The runway which he is directed to use will be outlined by lights, with powerful floodlights operating from the two ends of that particular runway. All buildings are marked out for him by red obstruction lights. Each runway is bordered by contact lights, spaced 200ft. apart, and each fixture is set in the ground and projects only 2in. above the surface. These lights can throw two beams along the runway—one horizontal and the other 15 deg. from the horizontal. The brightness of these lights is regulated from the central control tower to suit the prevailing conditions of the weather, and the operator has at his disposal a choice of three different degrees of brilliancy. These lights show amber for the first 3000ft. of a runway and white for the remainder, with filters so placed that the same sequence holds from whichever end of a runway a machine approaches. There are 204 of these runway contact lights at the airport. The ends of each of the four runways are marked by green range lights ; and at each end of each runway there are two narrow-beam floodlights, each of 7,500,000 candle power. Each runway and taxi runway shows red traffic lights when in use. Across the taxi strips leading to the runways are treadles which notify the control operator that a machine is entering upon or leaving a given runway.

The field is outlined by 85 boundary lights spaced 250ft. apart. These lights are of the prismatic type and give a piercing amber coloured beam. They are alternately connected on two circuits so that if one circuit fails only every other light will be affected. The apron is illuminated by floodlights mounted on the hangars, five on each building. The red obstruction lights on top of the hangars are neon tubes with automatic switchovers so that should one tube fail another tube will go on automatically, an indication being given at the same time to the control operator that a tube has gone out of service. When a machine has landed on a runway, the floodlights and the runway contact lights go out and the taxi lights go on, indicating to the pilot the taxi lane by which he is to reach the loading apron and the assigned platform station.

The control tower on top of the landplane administration building is the directing centre of the above-described system of night lighting for the field. The operators at that point have before them a desk on which the airport is shown in miniature. Small lights on the board go on and off in keeping with those on the landing areas. Those lights for night use, which are displayed continuously, such as the boundary and obstruction lights and the lights on roads and parking spaces, are controlled by astronomical time switches which turn them on at sunset and off at daybreak, subject, of course, to the voluntary control of the operators.

It is reported that the electrical wiring and associate apparatus in the control room constitute not only one of the most intricate but one of the most efficient systems ever installed. The extensive and complex lighting system called for the laying of a network of underground cables in ducts that cover the entire field. All told, approximately 800,000 linear feet—some 160 miles—of ducts were used. Bowery Bay is illuminated by two banks of floodlights so situated that the pilot, whether taxi-ing in or out, does not get the glare in his eyes. Each of the two banks is composed of three floodlights of 3000 watts each, that is, 18,000 watts for the two banks. Lighting at the marine terminal, including the terminal building, the seaplane hangar, and the floodlights on Bowery Bay is controlled from the terminal and is tied in with the landplane administration building so that the entire airport operates as a single unit. At the north end of the airport there is a 22ft. wind-T which gives the pilots the direction of the wind and serves as a guide in indicating the runway he should preferably use in daylight landings. The same wind-T is connected with an indicator in the control tower for the information of the operator stationed there. This wind-T may be manœuvred from the tower in order to enable the operator to indicate to a pilot which runway he should use.

The airport now has its initial equipment for landing by instrument—so-called " blind landing." That installation serves only runway No. 2, 5000ft. long, which has its longitudinal axis running from north-east to south-west. The transmitting station lies 3·8 miles distant, in Maspeth, Long Island, beyond the south-westerly end of the runway. The system used is known as the SMRAZ-D unit. When a pilot is on the beam he receives a continuous signal through his earphones. Should he be to the left of the beam, he hears the code letter N—a dash and a dot—constantly repeated ; and should he be to the right of the beam he hears the code letter A—a dot and a dash. When a pilot passes over the transmitting station he receives a high frequency note coming from a transmitter known as a Z marker. Halfway between the transmitting station and the airport there is another Z marker ; these two markers give him his exact distance from the runway. From this information and his known altitude he can quickly compute the required gliding angle. A pilot can come in on the same beam from the north-east—the Z markers for his guidance on that route being placed at College Point, on the eastern shore of Flushing Bay. The airport authorities plan to equip runway No. 1, 6000ft. long, for instrument landing, and they propose to use for that purpose the Bendix Benz-beam system. With that system the pilot holds his course on the beam by watching two dials on his instrument board instead of listening through his earphones.

Auxiliary outlets for radio, light, or power use are available at each end of all runways. Radio receivers, including those of the airport itself and those of the several airlines, are situated on Riker's Island in order to eliminate electrical interference from motor cars and machinery. A 200-pair submarine cable connects the towers on the island with the control tower of the landplane administration building, and from the latter distribution is made to the operating offices of the airlines, where they are amplified. Radio transmitters for the airport control tower are also mounted on the landplane administration building ; and those for the airlines are situated in the marshes of Jamaica Bay, on the south side of Long Island, some 15 miles distant from the airport, to which connection is made through the telephone company's wires.

Current for power and light is obtained from an electricity public utility and is taken from four 27,000-volt primary feeders that connect with four separate substations. The four feeders are kept entirely apart from one another so that the failure of one will not affect any of the others. The current is stepped down by three transformers at the airport to 120–208 volts for service. Current for field lighting is taken off from two of these services and is stepped up to 5000 volts, at which pressure it is transmitted to the floodlights and runway contact lights, where, again, it is stepped down to the required voltages. By using this high voltage for transmission across the field a large saving in copper was realised. In addition to the telephone company's connections in the various buildings, there is a private telephone system installed in all the structures. There are six dial exchanges in this private system, and each exchange can handle about 100 connections. The system of vocal communication is thus ample enough to meet any present maximum requirements and to anticipate increased demand for a considerable while to come.

The situation of the airport and the nature of so much of the ground forming it presented a problem to the engineers in assuring proper drainage. The airport is provided with two drainage systems : a subsurface system that takes care of ground water, and a surface system that carries off storm water. The subsurface system is complete for the apron and roadways, and crossovers have been provided under the runways so that surface drainage for the field

can be installed at any point at any time without interfering with traffic. The subsurface drainage system is relied upon to lower the ground-water table, and consists of broken-stone trenches and 6in. perforated corrugated iron pipe laid on each side of all runways and taxiways. The water flows into junction basins, constructed about 400ft. apart, and from the basins the water is carried off through concrete and vitrified tile pipes that range from 8in. to 36in. in diameter and empty into the river and the two bays through 14 outlets situated around the perimeter of the field.

The storm-water drainage system is capable of handling a runoff of 1in. per hour—a capacity that is about twice that required for very severe storms in the neighbourhood. Brick catch basins, with cast-iron covers, are spaced about 200ft. apart along the edge of the apron and the roadways. The basins range from 3·5ft. to 4·5ft. inside diameter and from 4ft. to 12ft. in depth. The basins drain into the same pipes that carry the ground water to the East River. Because of the corrugated iron crossover pipes already laid under the runways at depths from 8ft. to 10ft., and by reason of the large diameter pipes already installed at the sides of all runways as a part of the subsurface drainage system, brick catch basins may be put in anywhere in the field where conditions warrant them. Sanitary sewers connect all buildings with a new city sewer that runs across the south-west corner of the field and empties into the new sewage-disposal plant that has been built by the municipality westward of the airport.

Water is supplied to the airport by high-and-low-pressure systems. One 12in. and one 16in. main deliver water to a 24in. main for the landplane base and to two 12in. mains feeding a 12in. main for the marine base. The two systems are interconnected by a 16in. main so as to maintain the supply to both bases, should one or the other system fail. At the landplane base, the 24in. line continues on to the administration building, and from that point the line runs on to the hangars eastward as an 18in. main. The 24in. low-pressure line branches at a pumping station, situated between hangars Nos. 3 and 5, and connects to feed tanks and pumps by an 18in. line. From the pumping station a 24in. high-pressure line, operating at a pressure of 100 lb. per square inch, delivers water to all buildings in both the landplane and the marine bases for fire protection. At seven points along the line fire engine connections are provided so that in case of failure of the airport pumping station the New York City Fire Department can make connections to both the high- and the low-pressure lines and build up the pressure in the lines for emergency service.

All buildings are equipped with the automatic sprinkler system. The hangar areas have a deluge system which is brought into operation by a rate-of-rise method; and the office and shop areas of the hangars have a standard wet-pipe system, which is controlled by a variable-pressure alarm valve. The operation of any sprinkler valve causes the sounding of a code number, indicating the affected building, on all fire-alarm gongs. It also will record and time-stamp the code number on a register in the Port Manager's office, and sound a bell in the building in which the operated valve is situated. In addition, there is a city fire-alarm box in each of the two base administration buildings.

As at present equipped, LaGuardia Field is capable of handling 720 planes, in and out, in the course of 24 hours. At present the port is serving the American Airlines, Trans-continental and Western Air, Inc., United Air Lines, and Canadian Colonial Airways. The Pan-American Airways Company is the lessee of the single seaplane hangar. Steps are being taken to prepare the airport to function as the metropolitan base for trans-Atlantic service. During the first seven days of the operation of the airport there was a combined total of 925 flights, both arriving and departing, and 7600 passengers were carried.

The preliminary plans for the airport were prepared by Messrs. Delano and Aldrich, architects, who had previously designed six other airports. The task of preparing the final working drawings was assigned to the design section of the Work Projects Administration, a Government relief organisation. This section was under the direction of Mr. Samuel E. Stott, chief engineer, who was assisted by a board of engineers composed of Mr. Walter Douglas, of the New York engineering firm of Parsons, Klapp, Brinckerhoff, and Douglas; Brigadier General M. C. Tyler, assistant chief of engineers, U.S. Army; and Mr. Joseph A. Meehan, acting chief engineer of the Department of Docks of New York City. For the Government, the work has been carried forward under Lieutenant Colonel Brehon Somervell, administrator for New York City of the WPA, and Commissioner John McKenzie, head of the Department of Docks of the municipality. Many engineers and other experts have aided in carrying forward the undertaking to completion. The project has been one especially favoured by the Mayor of the City, Fiorello H. LaGuardia. Four illustrations of the airport appear on page 208.

French Locomotive with Velox Boiler

THE usual type of boiler, with which practically every locomotive is equipped, has scarcely changed since the early Stephenson locomotive days. It has always comprised an arrangement of smoke tubes and the draught is produced by the exhaust steam from the cylinders.

In spite of the fact that many remarkable locomotives have been designed utilising this principle, this form of boiler presents several disadvantages. Its efficiency, although quite high, can be considerably bettered. With coal firing the efficiency reaches an average value of 70 per cent. and with oil firing about 80 per cent., but under service conditions in railway working, the efficiency of coal-fired locomotive boilers is frequently reduced to about 60 per cent. Furthermore, boiler pressures after having been raised progressively up to about 350 lb. per square inch, appear to have reached a limit resulting from the attendant increase in maintenance charges and constructional difficulties. Finally, the mass of water in the boiler is of the order of 8 tons, and raising its temperature to the boiling point from cold takes about four hours, causing both loss of time and loss of heat units.

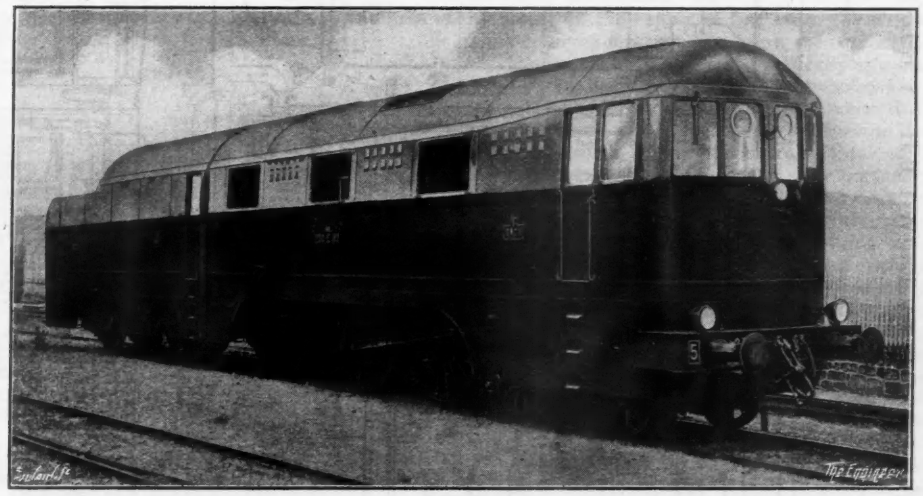


FIG. 1—LOCOMOTIVE WITH VELOX BOILER

In France, development work has proceeded for some time on alternative arrangements. For some years, water-tube boilers for locomotives have been made, and we now learn that the French National Railways (S.N.C.F.) have ordered from the Société Alsacienne-Fives Lille-Schneider group a locomotive with a water-tube boiler rated at 60 atmospheres (about 890 lb. per square inch) which will soon be put in service.

Another type of boiler which has attracted the attention of locomotive designers is the Velox, a forced-circulation type, which has already been used in numerous installations, on board ship for example. A Velox boiler designed for oil firing has now been installed in a 2–3–0 type locomotive of the French Railways, and the locomotive is in service on the south-eastern section of the S.N.C.F.

In the following article, a description of this locomotive, based on an article by Monsieur Chau, chief engineer of the Research Division of the S.N.C.F., published in *La Revue generale des Chemins de Fer*, is given.

In the Velox boiler, combustion takes place in a chamber maintained at a pressure of about 35–40 lb. per square inch absolute, with the result not only that the combustion reactions are more active, but that they are enabled to take place in a considerably reduced volume. This pressure is created by an air compressor coupled to a turbine driven by the boiler exhaust gases.

Furthermore, the forced-circulation Velox boiler is characterised by a very rapid gas circulation. The combustion gases circulate at speeds varying from 200 to 60 metres per second, according to the points in the circuits at which measurements are made. This high gas velocity leads to high co-efficients of heat transfer, and, in consequence, to a reduction in the area of heating surfaces required.

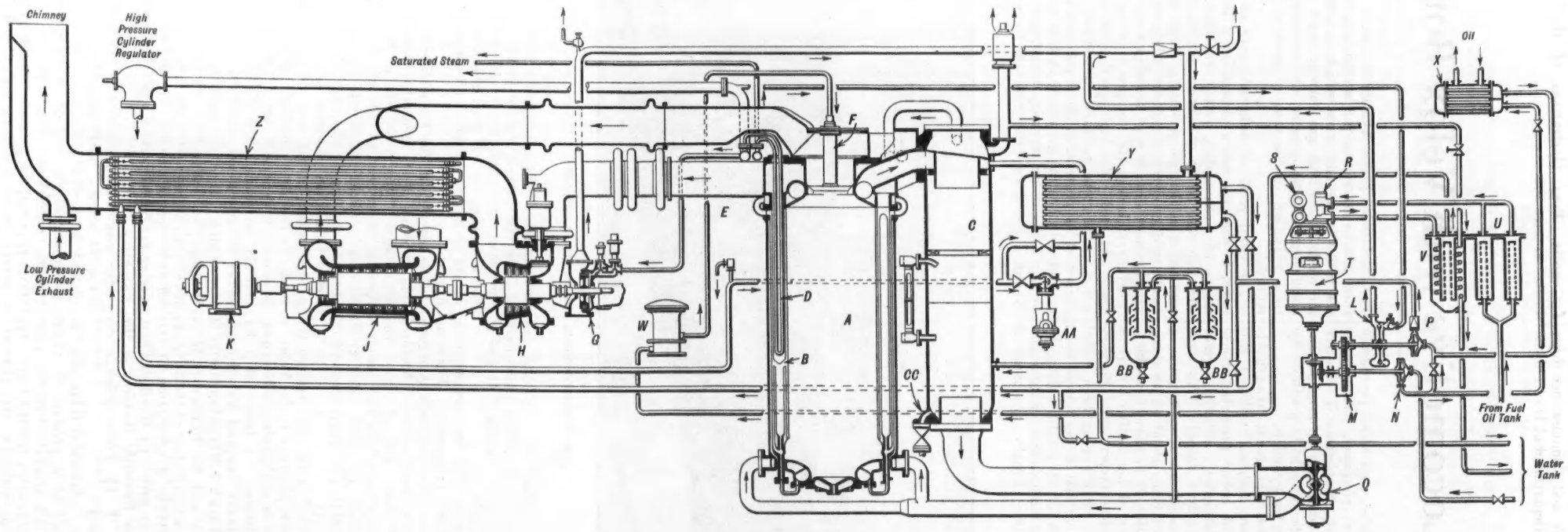
The third point of difference with the Velox boiler is that the water circulation is forced by means of a circulating pump, enabling a high steaming rate to be obtained; for example, in continuous service, about 450 kg. steam per hour can be produced per square metre of heating surface surrounding the combustion chamber, and for highly rated naval boilers 700 kg. per hour have been easily obtained. The high speed of water circulation in the steam raising elements has, besides, the effect of preventing these tubes from being subjected to heating greater than that withstood by the tubes of an ordinary boiler, and of considerably decreasing the rate of formation of incrustations. The amount of water in circulation is about ten times the rated steam production of the boiler, and consequently the steam from the boiler contains at full load about nine times its weight of water, separated afterwards by special means.

Considered from the locomotive point of view, this type of steam generator possesses several advantages. Firstly, it has a high efficiency, reaching 88 per cent. at full-load, and about 82 per cent. at half-load, taking into account the energy absorbed by the auxiliaries. Hence by using a Velox boiler fuel economy can be effected, for normal boilers at full load do not possess more than 70 per cent. efficiency. Secondly, steam pressure can be rapidly raised. With a cold boiler and the auxiliaries at a standstill, ten minutes suffice to raise steam, which can then be supplied immediately in the quantities necessary for starting the locomotive. It is therefore not necessary to keep up the fire in the furnace during off-service periods, and the fire can be extinguished during prolonged periods when the locomotive is stationary.

By reason of its low heat content, or low "calorific inertia," and the rapid-acting regulating devices used, the Velox boiler is also claimed instantaneously to respond to alterations in the running conditions. Whatever the amount of steam required, the pressure remains substantially constant at the regulator valve, and a sudden interruption in the demand does not cause the safety valves to open. Therefore, this type of boiler is very flexible in operation.

For equal steam-raising capacities, a Velox boiler is more compact than the ordinary type.

FRENCH LOCOMOTIVE WITH VELOX BOILER



"THE ENGINEER"

Boiler—
A—Combustion Chamber.
B—Evaporating tubes.
C—Water separator.
D—Superheater tubes.
E—Superheated steam collector.
F—Oil burner.

Auxiliary Group No. 1 (Charging Set).
G—Steam turbine.
H—Gas turbine.
J—Air compressor.
K—Starting motor.

Auxiliary Group No. 2 (Pumping Set).
L—Steam Turbine.
M—Gears.
N—First stage feed pump.
P—Second stage feed pump.
Q—Circulating Pump.
R—Fuel oil pump.
S—Lubricating oil pump.
T—Starting motor.

Fuel Oil Circuit.
U—Fuel oil filters.
V—Fuel oil heater.
W—Air-oil mixture regulator.

Feed Water Circuit.
X—Oil cooler.
Y—Feed water heater.
Z—Economiser.
AA—Feed water regulator.

Circulating Water Circuit—
BB—Decanters.
CC—Drain valve.

Starting Equipment—
DD—Oil engine.
EE—Generator.

DIAGRAMMATIC ARRANGEMENT OF BOILER AND LONGITUDINAL SECTION OF LOCOMOTIVE

It follows, therefore, that for a locomotive with given dimensions, it is possible to obtain with a Velox boiler greater steaming capacity, and, should the adhesive weight permit, greater tractive effort.

Furthermore, the Velox boiler is very simple to operate. Pressure is maintained practically constant by the automatic regulation of the oil injected by the burner, the quantity of combustion air is regulated automatically as a function of the fuel fed, and the feed water is also supplied in an automatic manner. Hence all the operator or driver need do is to watch the mechanisms work.

Finally, an advantage is claimed in respect of the elimination of explosion risks. The combustion chamber and gas ducts of a Velox boiler are designed to resist abnormal pressures which might be set up by a broken vaporising element, or the premature explosion of an oil-air mixture. Besides, the quantity of water in circulation in the steam raising portion is small, and the fracture of a steam tube could not allow the instantaneous formation of a large volume of steam, with disastrous consequences.

Because of the numerous advantages of this boiler arrangement, the French National Railways decided to accept the offer of the Compagnie Electro-Mécanique, licensees of Brown-Boveri and Co., Ltd., for France, to construct an experimental Velox boiler on a 2–3–0—B.93 locomotive. The frames, cylinders, and driving motions were left unchanged, so as to enable comparisons with the normal boiler arrangement to be easily made. The completed locomotive, fitted with a Velox boiler, is illustrated in Fig. 1.

This locomotive, which had been designed for a working pressure of about 228 lb. per square inch, and has driving wheels 2 m. in diameter, had a maximum speed of 120 Km./hour, or about 75 m.p.h., and an indicated power of 1500 H.P. The Velox boiler now installed has a rated pressure of about 284 lb. per square inch, and is capable of raising 12 metric tons per hour of steam superheated to 380 deg. Cent. of which 11 metric tons per hour are available at the cylinders.

In describing the locomotive, we will deal firstly with the Velox boiler arrangement, then the auxiliary installations, and finally with its operation. On the opposite page is reproduced a diagrammatic arrangement of the locomotive, and below it a longitudinal section; the reference letters in the legend are common to both drawings. The photograph reproduced in Fig. 2 shows the completed locomotive without its coachwork, and in it there can be distinguished the cylindrical combustion chamber surmounting the two rear coupled axles.

Referring to the drawings on the opposite page, the boiler consists of a cylindrical combustion chamber A, made from steel plate, within which are arranged vaporising elements B, formed by three concentric tubes welded to suitably shaped steel pieces. The central tube and the annular space formed by the two other tubes are traversed from bottom to top by the water to be vaporised, whilst the hot gases produced by combustion likewise travel from bottom to top in the remaining annular space.

At their lower ends, these elements are open to a circular cast steel chamber, forming the bottom of the water heating chamber, to which feed water is supplied; at their upper ends, they communicate with a chamber, also of cast steel, for the reception of the mixture of water and steam given off. Passing from this chamber, the mixture is led to a water separator C, of cylindrical shape, into which it is directed tangentially along the inner periphery. By reason of centrifugal force, the water is thrown outwards and falls to the base of the separator, which forms a water reserve.

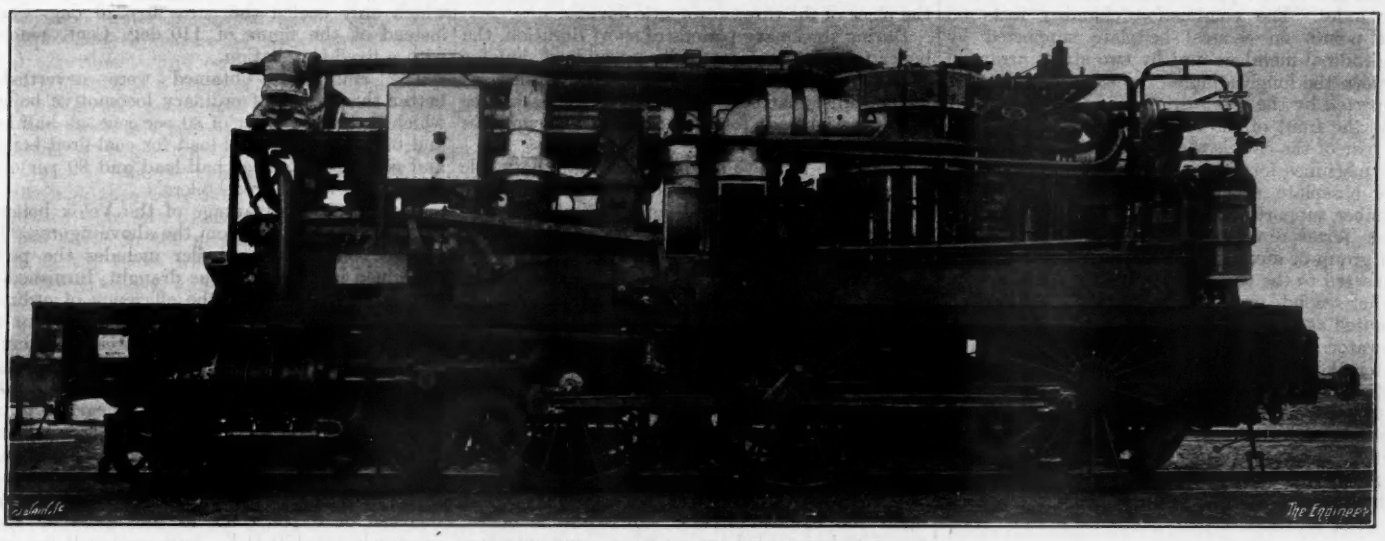


FIG. 2—COMPLETED LOCOMOTIVE WITH COACHWORK REMOVED

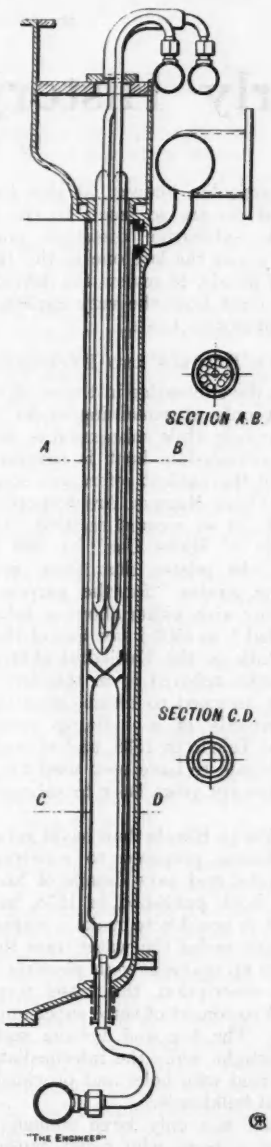


FIG. 3—SECTION THROUGH STEAM RAISING AND SUPERHEATER TUBE ASSEMBLY

Saturated steam from the top of the separator is led to a collector surrounding the upper part of the generator, to which are attached all the superheater tubes D. These tubes are arranged within the steam-raising tubes, taking the place of a part of the central tube, as shown in Fig. 3. Steam issuing from the superheater tubes is led to a second circular collecting chamber E, from which is taken a pipe leading to the steam admission regulator for the cylinders of the locomotive. This pipe is provided with a pressure regulator which maintains the steam pressure at a practically constant value, by acting on the supply of fuel oil to the burner. The oil burner F is mounted below the combustion chamber and the fuel is injected vertically upwards.

A first auxiliary group of machinery comprises a steam turbine G, and a gas turbine H, which drive an air compressor J, furnishing combustion air. The gas turbine regains the energy contained in the hot gases leaving the boiler after traversing the steam and superheater tubes, and it develops practically all the power necessary for driving the air compressor, the steam turbine being only required to give a small amount of power enabling the speed of this auxiliary group to be accelerated when sudden increase of steam production is required. At one end of the group is mounted a D.C. motor K, which is only used for starting the system, and is automatically disengaged as soon as, after the burner is lit, the hot exhaust gases reach the gas turbine and enable it to provide the power output.

A second group of auxiliaries consists of a steam turbine L driving through a train of gears M the first stage feed pump N, and, driven directly therefrom, the second stage feed pump P. The steam turbine also drives through gearing a vertical shaft connected to the circulating pump Q, which is fed from the lower part of the water separator, already mentioned. Also driven therefrom are the fuel oil pump R and the oil pump S for lubrication and control purposes. Finally, the group contains a D.C. motor T for starting from cold.

Fuel oil is drawn from a tank through filters U, which can be cleaned while in motion, by the fuel oil pump and is passed on to an oil heater V. From this apparatus the oil is led to the burner by way of a regulator W which controls the air-oil mixture. This regulator alters the speed of the charging compressor set so as automatically to provide the correct amount of air for burning the fuel required under varying load.

Feed water is likewise stored in a tank, from which the two-stage feed pump forces it through an oil cooler X, the feed water heater Y and the economiser Z, whence it flows into the separator through a feed regulator AA, which controls the feed in accordance with the water level in the separator. The feed water heater operates with the exhaust steam from the two auxiliary steam turbines, and the condensed steam is returned to the feed tank. The economiser functions by the heat withdrawn from the gas turbine exhaust gases, which are finally discharged through the chimney.

Part of the circulating water delivered by the circulating pump passes into decanters BB, of the "Dejector" type, enabling the boiler feed to be chemically treated. In addition, a drain valve CC is provided on the water separator.

An oil-engine driven generating set supplies the electric starting motors of both auxiliary groups, when starting from cold. So soon as the boiler has raised steam, this set is shut down. The oil

engine is indicated at DD in the diagram and sectional view, and the generator at EE.

The installation of the various components of the Velox boiler on the locomotive chassis was carried out by the Ateliers d'Haumont des Aciéries du Nord, a firm which was also entrusted with the maintenance and servicing.

The boiler is mounted vertically between the frames and in the space available between the two rear axles. The combustion chamber rests on four points on a steel bedplate supported by longitudinal members and by two struts arranged between the longitudinals. The steam separator is supported by the combustion chamber.

At the front of the locomotive, immediately to the rear of the cab, is the first group of auxiliaries. The machines forming it are mounted on a thick steel baseplate which is tied to the combustion chamber supports and to the frames, so that the whole forms a very rigid structure. Above the first group of auxiliaries is placed the economiser, connected to the chimney.

The second group of auxiliary machines is mounted at the rear of the locomotive, behind the separator, and near this group are placed the oil heater, the lubricating oil cooler, the air-oil mixture control, and the feed water regulator. Water and oil tanks are provided in the tender, and the oil-electric generating set is also installed there.

Steel panels are arranged to cover the locomotive; they are supported by a fixed framework, solid with the baseplate and locomotive frames, and so

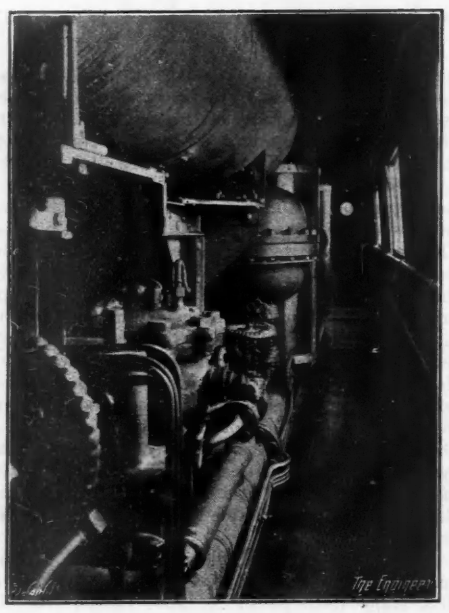


FIG. 4—ACCESS CORRIDOR WITHIN LOCOMOTIVE

arranged that all the components of the boiler can be readily dismantled. Two corridors are arranged within the coachwork, or casing, so that the boiler and all its components can be inspected while the locomotive is running. The engraving, Fig. 4, shows one of these access corridors.

The driver's cab, situated in front, is separated from the machinery by a bulkhead and two transverse doors. Placed before the driver in the same position as found on the ordinary locomotive are the reversing gear, the regulator, starting gear, brakes and whistle controls, a Flaman recorder, and so forth. On a panel are arranged controls for the sanding gear, cylinder-cocks, valves for train-heating and the air pump, lubricators, &c., as well as the Velox boiler controls.

In operation, when the locomotive is required for service, the oil-engined generator set, operating on Diesel oil, is started up. Current supplied from the generator is then sufficient to drive, at a reduced speed, through their respective electric motors, the two auxiliary groups of machinery. Firing the boiler is effected by means of an electrically heated resistance, utilising Diesel oil contained in a small auxiliary tank. It would be impossible in these conditions to fire the boiler on furnace oil, unless an external source of heat for the oil were provided. Several minutes after lighting up, pressure is raised and the pressure regulator begins to function, maintaining it at its full value. In the meantime, the boiler is switched from Diesel oil firing to furnace oil firing, the furnace oil being heated by the steam raised. The turbines for driving the auxiliaries start functioning, and electric motor drive being no longer necessary, the generating set is shut down. The locomotive is then ready to start, and can exert its maximum tractive effort.

Alternative methods of boiler control are provided. Firstly, it can be operated through the automatic controls already mentioned, keeping the steam pressure and the water level in the separator constant, and proportioning the combustion air and fuel; or, if required, the control can be effected by hand by means of three controls which can take the place of the three automatic devices.

During stationary periods of short duration, the boiler functions automatically on no-load, but for a prolonged period of interruption of service, all the machinery can be shut down, with the assurance that it can be ready for service within a few minutes from restarting it.

In service tests we are informed that the whole of the operations necessary for raising steam were completed regularly in less than fifteen minutes. In spite of stops and changes of speed, often very sudden, the steam pressure remained between 263 and 313 lb. per square inch, and the superheat temperatures between 355 deg. Cent. and 380 deg. Cent. The power of the converted locomotive reached 1800 H.P. compared with the 1500 H.P. of the original, representing a gain of 30 per cent. This result is attributed partly to the compact nature of the Velox boiler, and partly to its higher pressure rating, namely, 284 lb. per square inch, instead of 228 lb. per square inch; finally, the absence of back-pressure in the exhaust system is also a factor, for the draught is not dependent upon the exhaust steam. Encrustation of the boiler, to be guarded against when using untreated water, was avoided in service trials by emptying the water in the separator and in the decanter after each run.

On the Vitry locomotive test bench, the locomotive was subjected to trials for determining the boiler efficiency between half- and full-load. With domestic fuel oil having a calorific value of 9587 lb.cal/lb., efficiencies obtained were 86 per cent at half-load and 84 per cent. at full-load; with an average fuel oil, having a calorific value of 10,131 lb. cal/lb., the efficiency was likewise 86 per cent. at half-load, but only 81 per cent. at full-load. An efficiency of 90 per cent., commonly reached in stationary Velox boilers, was not attained, because of the small economiser fitted, which only cooled the gases to 220 deg. Cent., instead of the figure of 110 deg. Cent. reached with a fixed installation.

The efficiencies obtained were nevertheless better than those of ordinary locomotive boilers, which are of the order of 80 per cent. at half-load and 65 per cent. at full-load for coal-fired boilers. and of 85 per cent. at half-load and 80 per cent. at full-load for oil-fired boilers.

Actually, the advantage of the Velox boiler is greater than appears from the above figures. The efficiency of a Velox boiler includes the power consumed in producing the draught, furnished by the gas turbine, whilst the efficiency of ordinary locomotive boilers does not take into account the energy contained in the exhaust steam serving to produce the draught. For example, the back-pressure of the exhaust steam from the cylinders of an ordinary locomotive reaches nearly 5 lb. per square inch, whilst that of the Velox boiler is less than 0·25 lb. per square inch. There results therefrom a gain in power which, for an indicated power of 1800 H.P., is 100 H.P. or equivalent to an increase of 6 per cent. in the speed at about 56 m.p.h., or 170 H.P., representing 9 per cent. of the speed, at about 75 m.p.h. In the ordinary locomotive the draught is produced by a system which is inefficient, especially at high speed, but in the Velox boiler the gas turbine is a machine with a high efficiency, which is independent of the speed of the locomotive.

Early History of the Submarine

By J. GORDON PEIRSON

IT is of particular interest at this time, when naval matters are so much to the fore, and two terrible submarine disasters, one in the U.S.A. Navy and the last one in the British, are fresh in our minds, to review the development of underwater craft from the very earliest attempts to build submersible boats.

EARLY RECORDS AND EXPERIMENTS

Although the submarine in the sense of a vessel capable not only of remaining under water but also of travelling while submerged is modern, the idea of a submersible boat is several centuries old. One of the earliest references occurs in the writings of Olaus Magnus, Archbishop of Upsala, Sweden, who in an account entitled "Of Leather Ships, made of Hides Used by the Pyrats of Gruntland," he relates that these vessels were used by the pirates "for the purpose of going wherever they wish, either above or below water," and adds that "in 1505 I saw two of these leather boats or skiffs in the Cathedral church, Asloe." The Gruntland referred to in this ancient record is generally assumed to mean Greenland. There are also records of a "diving vessel" being exhibited at Toledo in 1538, and of a submersible boat that is said to have been used by the people of Venice twenty years later to salvage a sunken galleon.

About 1578 an Elizabethan naval gunner named William Bourne proposed to construct a submersible vessel and gave details of his invention in a small book published in 1578, in which he wrote: "It is possible to make a shippe or boate that may goe under the water unto the bottome and so come up againe at your pleasure." According to his description, the vessel was to be of leather and to consist of three super-imposed compartments. The top and bottom sections were to be watertight while the intermediate one was to be "pierced with holes and provided with two longitudinal bulkheads."

The vessel was only large enough to accommodate one person, who could cause the boat to sink by drawing inward the bulkheads and admitting sufficient water to the centre compartment, through the perforations in the side of the vessel, to reduce the buoyancy of the craft to the required degree. To raise the boat to the surface again the bulkheads were to be pushed outward, thus causing the water previously drawn into the compartment to be expelled. A hollow mast that projected above the surface of the water provided the occupant of the boat with fresh air.

King James I was interested in submersible boats and is said to have encouraged Cornelius Van Drebbel to construct an efficient submarine. Drebbel first conceived the idea in 1620, and during the next four years built three submarines, one of which is said to have accommodated "12 rowers besides passengers." Details of their construction are lacking, but a record dated 1645 informs us that the boat just mentioned successfully journeyed *under* water from Greenwich to Westminster, and adds that: "In this boat a person could see under the water and without candle light as much as he needed to read the Bible or any other book."

It is recorded that King James made a voyage in one of Drebbel's submarines in the Thames. Drebbel discovered some means of replenishing the air in his craft, but kept his method secret. When the air in the submarine became stuffy he is said to have resorted to a large bottle from which he withdrew a mysterious liquid that had the effect of purifying the air! After his death in 1634 his heirs endeavoured to obtain this secret for their own use, and their efforts culminated in a lawsuit in the King's Court, which is referred to by Samuel Pepys in his famous diary.

A quaintly worded royal warrant dated 1626 reads: "His Majestie to the Master of the Ordance, for the makyng of dyvers water mines, water petards, fforged cases to be shot with fireworks, *and boates to goe under the water.*" A year later a royal warrant was also issued to the Duke of Buckingham in the following terms: "360 fforged iron cases with fireworks, 50 water mynes, 290 water petards, *and two boates to conduct them under water* for H.M. present services to goe with the fleete."

About this time several inventors both in this country and France had schemes for constructing underwater craft. Among them were two French priests, Fournier and Mersenne, who in 1634 published a small book detailing their ideas. They stated that the submarine should have a metal hull and be made as nearly fish-shaped as possible. Another inventor named Jean Barrie was granted

a patent by the French King in 1640, giving him authority to "fish at the bottom of the sea" with his boat "at any time during the ensuing 12 years!"

About 1774 a wheelwright named Day, living in Suffolk, became interested in the subject of submersible boats. He obtained one of the small boats in common use on the Norfolk Broads and equipped it with a covering to render it totally enclosed and watertight when submerged. In this improvised submarine he made several successful experiments and on one occasion is said to have remained at a depth of 30ft. for 24 hours.

Day was greatly encouraged by his success, but he lacked the funds necessary to cover the cost of building a larger and improved vessel. He endeavoured to raise the money among his friends, but, although they were interested in his experiments, they were loth to risk any capital. There happened to be in the neighbourhood, however, a man named Blake who had a reputation for making novel wagers, and by artful conversation Day interested Blake in the possibilities of a man being able to remain under water at a considerable depth for a long period without injury or discomfort.

Blake then challenged any man to descend into the sea to a depth of 100ft.; in any contrivance, and, after being continually submerged for 12 hours, without any assistance from or connection with the outside world, to rise to the surface again none the worse for the adventure.

Day accepted the challenge, and it was arranged that the event should take place in Plymouth Sound. He secured a small craft and built a watertight compartment in it. When all was ready a trial was carried out in shallow water in Blake's presence. The vessel was submerged six hours before full tide and remained under water till six hours after the turn of the tide. Day remained shut up in his tiny watertight compartment throughout the period.

On the appointed day the vessel was towed to an agreed place, and special ballast was placed on board in sufficient quantity to ensure that it would sink after a certain quantity of water was admitted. The ballast consisted in part of two heavy detachable weights connected with the watertight cabin in such a manner that, at the conclusion of the 12 hours' submersion, Day could detach them and cause the boat to rise to the surface.

An interesting account of the subsequent happenings is given in the *Annual Register* of 1774: "Mr. Day provided himself with whatever he thought necessary, he went into the vessel, let the water into her and with great composure retired to the room constructed for him, and shut up the valve. The ship went down gradually in 22 fathoms of water at two o'clock on Tuesday, June 28th, in the afternoon, being due to return at two the next morning. He had thirteen buoys or messengers which he could send to the surface at option to announce his situation below; but none appearing, Mr. Blake, who was near at hand in a barge, began to entertain some suspicion. He kept a strict look-out, and at the time appointed neither the buoys nor the vessel coming up, he applied to the 'Orpheus' frigate which lay just off the barge, for assistance."

In spite of prolonged efforts to locate and rescue Day and his submarine, neither was ever seen again. Probably the boat was too frail to withstand the pressure of the water at the depth to which it descended, and was crushed to pieces.

In the following year an American named David Bushnell completed the construction of a submersible boat that he had planned and commenced to build in 1771. During his school studies in chemistry Bushnell had become greatly interested in the problem of how to discharge effectively explosive powder under water, and had come to the conclusion that a submersible boat offered the best means of accomplishing this.

The vessel built to his design resembled the upper halves of a pair of turtle shells joined together, the natural opening where the head of the turtle would be being occupied by a small conning tower by which entry was made to the boat. A false keel consisting of 200 lb. of lead was placed at the bottom of the boat to maintain it in a vertical position. The submarine only accommodated one person, and although there was no arrangement for renewing the supply of air, experiments proved that the occupant could remain under water 30 minutes. It was propelled backwards and forwards by means of a projecting oar situated near the front and rotated by the feet of the navigator working a pedal. A rudder was fitted at the rear.

As in the case of Day's submarine, water was relied upon to start the boat sinking, and this was effected by opening a valve in the bottom of the boat. When sufficient water had been admitted, downward progress was continued by an oar, functioning as a vertical screw, that was fitted in the top of the boat. To elevate the submerged boat the water was ejected by means of two force-pumps. The compartments set aside for receiving the water corresponded to the water ballast tanks of a modern submarine. The extent to which the craft descended or rose was registered by a water gauge, while a compass furnished the means of keeping the vessel on a desired course. As there was no means of illumination this compass was treated with phosphorous so that the navigator could see in the dark.

The vessel was designed to function as a war unit and was provided with a magazine charged with explosive powder, the idea being silently to approach the vessel selected as the submarines' prey, attach the magazine to the ship's hull, and subsequently fire the charge. A device that resembled a huge screwdriver and carried a screw loosely attached to its upper end was fitted to the top of the submarine in such a manner that the occupant could manipulate the screw while the boat was submerged. The magazine of explosive, together with a clock-work mechanism by means of which the powder could be fired at a prearranged time, was attached to one end of a short cord, the other end of which was fastened to the screw.

Owing to ill health Bushnell was unable to operate his submarine when it was completed, and his brother was trained to work it. At this time the American War of Independence was in progress and Bushnell decided to test the efficiency of his craft at the expense of some of the British warships then in New York Harbour. He selected the warship "Eagle" as his first victim and arrangements were made for his brother to use the submarine to torpedo the British vessel. Before the appointed time for the venture, however, Bushnell's brother also became ill and his place was taken by a man named Eyre Lee.

Boarding the submarine as it lay alongside the parent ship in the Hudson River, Lee began his hazardous exploit and skilfully navigated his boat until it was close to the unsuspecting warship. "When I rode under the stern of the ship," he afterwards related, "I could see the men on deck and hear them talk. I then shut down all doors, sunk down and came up under the bottom of the ship." Lee then operated the screwdriving device and the screw began to pierce the wooden keel of the warship. A small iron plate or bolt fastening on the ship's bottom prevented the screw from taking hold, and as the tide slowly carried the submarine away the screw came away from its socket. Lee endeavoured to locate a more vulnerable part of the ship's hull for the screw, but in his manœuvres he eventually completely "lost" the warship.

Rising to the surface again he was dismayed to find that dawn was breaking, and fearing that he would be observed by those on board the warships, or by the garrisons at the forts, he made a hasty return to the parent ship, and while doing so, located the "Eagle" again, and immediately discarded the magazine, which was carried away by the tide. It floated a considerable distance from the warship by the time the charge exploded an hour later, but the loud report and the great column of water that shot up into the air caused considerable alarm on board.

The incident roused the British to the need of greater watchfulness and two further unsuccessful attempts to blow up the warship were made before the submarine was traced to its lair. The parent ship with the tiny underwater craft aboard was then pursued and sunk, but Bushnell later successfully salvaged the submarine—the first submarine salvage in history!

If Bushnell's vessel had achieved the object of sinking the warship, the submarine would have been proved an efficient weapon of war. As it was, the American authorities remained sceptical as to its merits, and Bushnell became discouraged, and eventually went to France, only to find the French Government as equally unenthusiastic. Nevertheless Bushnell's craft of 1775 may be looked upon as the first practical submarine.

Forerunner of the Modern Submarine

The utility of the submarine as a weapon of war was realised by the famous American engineer, Robert Fulton, who was one of the pioneers of steamships. In 1797 Fulton went to Paris and began his experiments with submersible boats and submarine torpedoes. His first submarine was of cigar shape and was called the "Nautilus." This vessel was launched on the Seine near Rouen on July 30th, 1800. It did not satisfy Fulton, however, and a second and improved vessel was constructed almost immediately afterwards. It also was named the "Nautilus" and was completed in May 1801. It was 21ft. 4in. long and 7ft. in diameter amidships. The hull consisted of a framework of iron ribs covered with wood sheathed with copper, while a horizontal keel extended the whole length of the boat to give increased stability. The vessel could accommodate two men and entrance was effected by way of a small dome-shaped conning tower at the forepart of the hull. A short mast that could be laid flat on the deck when not in use was provided to enable the boat to travel on the surface under sail.

When submerged, this boat travelled under the impulse of a small propeller at the stern, mounted at the end of a shaft that was rotated by a hand-wheel in the navigator's compartment. A rudder was fitted, while compressed air was provided in sufficient quantity to enable the occupants to remain under water for several hours. Submersion was achieved by admitting water into special compartments, or ballast tanks, and the magazine of explosive carried, and method of discharge, were similar to that devised by Bushnell.

When the improved "Nautilus" was completed, Fulton tested it in the Seine near Paris, and later journeyed in it to Brest. It is said that the gunners in the French forts that he passed were thrown into "fits of consternation" by the sight of the vessel periodically disappearing beneath the surface of the water and suddenly coming up again some distance ahead! Napoleon was sufficiently impressed by it to grant Fulton £250 with which to continue experiments.

The tests carried out at Brest were witnessed by the authorities of the French Navy, and the manœuvres included the sinking of a pontoon by attaching to it a magazine and firing the explosive from an underwater position. Fulton later visited England, but the British Admiralty were not impressed, and he returned to America, where he designed and built a submarine capable of carrying 100 men. It was 80ft. long, 21ft. wide, and 14ft. deep, and travelled so silently that it became known as the "Mute"; but Fulton died before it was completed. This vessel was used during the second American War of Independence, and it is possible that it took part in the attempt to blow up the British warship "Ramillies" anchored off New York.

It was a long time before any further development of underwater craft took place. But in 1850 a German named Bauer invented a submarine, and as his own country was not interested he brought his plans to England. He submitted the details of his submarine to the Admiralty, and although they were not at all enthusiastic about the matter, a Government Committee was formed to consider his claims and proposals. It was formed of a number of prominent engineering experts of the day, and included I. K. Brunel. But their report was unfavourable.

About this time, a submersible boat propelled by compressed air was invented by a French naval officer named Commandant Bourgeois. This was built at Rochefort in France, but when tested proved a failure. During the American Civil War the Southerners sought to defeat the blockade carried on by the Federal forces by constructing several torpedo boats capable of being submerged when near their objective. Each vessel was equipped with movable planes or fins, the manipulation of which caused it to dive or rise to the surface as required, while special ballast tanks could be filled to aid submersion.

This is the first time we hear of "movable planes." Many of these boats could only be submerged to an extent that brought their deck level with the surface of the water, but this was sufficient to submerge the spar that projected from the bow and carried the torpedo. Each vessel had a crew of about eight men.

On February 17th, 1864, one of these submersible boats succeeded in torpedoing and sinking, off Charleston, the "Housatonic," a Federal frigate of 1264 tons and having an armament of 13 guns. The boat that carried out this feat, however, was itself wrecked by the explosion, and only the captain was saved.

In 1878 a submarine was designed by a clergyman named Garrett and constructed at Liverpool.

Successful tests were carried out in the Mersey, and among those who witnessed the manœuvres was the Swedish engineer Thorsten Nordenfelt, the inventor of the gun that is named after him. Nordenfelt was greatly impressed by the success of Garrett's craft, and after carrying out experiments on his own account, he built a small submarine 64ft. long and of 60 tons displacement. The motive power for both surface and underwater propulsion was obtained from a steam engine. The success achieved with this vessel led to the construction of a larger one, 100ft. in length and of 160 tons displacement. A steam engine was again adopted to drive the propeller, and the boat attained a surface speed of 12 knots. She was equipped with two Nordenfelt 25 mm. quick-firing guns, and carried two torpedoes.

Normally the vessel was caused to dive or rise to the surface by the operation of vertical propellers, but she showed such a frequent tendency to dive, irrespective of the operation of these propellers, as to be of little practical use. In spite of this defect the two Nordenfelt submarines created a favourable impression among foreign powers, and the original vessel was purchased by Greece. The Turkish Government immediately ordered two similar submarines, and when completed they were sent to the Bosphorous in sections. One was put through various manœuvres in the presence of Mr. Garrett, who took command of one of the vessels, but the other was never completed. An improved type was built by the Barrow Shipbuilding Company and figured in the Naval Review of 1887. She was wrecked near Jutland on her way to Russia, by whom she had been provisionally purchased.

The tendency to dive and oscillate that had been evident in the original craft was present in these two vessels, and Garrett had difficulty in controlling his vessel. Water frequently invaded the conning tower before the lid could be closed down. These unsatisfactory features were realised by the Turkish Navy, and it was found impossible to persuade or compel sufficient men to man the submarines to operate them efficiently, and they were withdrawn from service.

The efficiency of all these early submarines was greatly impaired by the lack of engines combining both lightness and power, but developments in the use of electricity and oil fuel opened up new possibilities to inventors. One of the first to design an electrically driven submarine was the French engineer, Depuy de Lôme, who was one of the pioneers of rigid airships. He died before he had completed his designs, but years later his plans were revised and completed by his friend, Gustave Zede. The submarine built to his design was cigar shape, 59ft. long, nearly 5ft. wide, and of 60 tons displacement. A battery of 564 cells supplied current to a 55 H.P. electric motor, which provided the motive power for propelling the vessel both on the surface of the water and when submerged.

Its maximum surface speed was 6 knots, at which she had a radius of action of 35 miles on one charge of the batteries. By reducing speed one-third the radius was increased to 100 miles. The French Admiralty were so impressed with the performance of the "Gymnote," as the vessel was called, that they decided to add submarines to their Navy, and a submarine almost three times the length of the "Gymnote" was built. The new vessel was 160ft. in length, 12½ft. wide, and of nearly 270 tons displacement. Electric motors giving a total of 270 H.P. were installed, and the armament consisted of three 17½in. Whitehead torpedoes. It was named "Gustave Zede," after the builder of the "Gymnote," and it marked the beginning of France's fleet of submarines.

While these developments were in progress two inventors in America were independently engaged in perfecting submarines of their own design. They were Simon Lake and John P. Holland. Lake constructed his first submarine in 1894 and named it the "Argonaut Junior." It was built of wood and was 14ft. in length, 4½ft. in width, and 5ft. in depth. This inventor saw in the submarine a means of salvaging the great number of sunken wrecks strewn around the American coast, and therefore the "Argonaut Junior" was entirely different from any submarine built as a weapon of war.

It was fitted with three wheels to enable it to travel along the sea-bottom, while in the bow was a watertight compartment by means of which divers could enter or leave the boat as it rested alongside a wreck on the sea-bed. It could submerge to a depth of 20ft., and remain under water for several hours, an adequate supply of compressed air being stored on board. When the vessel was completed, minor salvage jobs were successfully carried out, and the profit obtained enabled the inventor to build a larger and more powerful craft.

Lake's second submarine was 36ft. long and 9ft. wide, and was named the "Argonaut." Like its predecessor, it was not a submarine in the full sense of the term, as it could not be propelled under the water. It was only capable of travelling on the surface by means of its screw, or along the sea-bed by means of three wheels—two forward and one aft. A 38-H.P. petrol motor was installed, together with an air compressor and a dynamo to provide current for lighting the vessel and also for a searchlight. Two long pipes, sloping slightly towards each other, projected above the deck to a height of about 30ft. The fore pipe served as an intake for fresh air, and the aft pipe, reaching down to the engine-room, provided an outlet for the vitiated air and the gases from the motor. The fuel tanks were situated below deck and outside of the hull proper in order to eliminate any danger of ignition from within the vessel.

Glazed apertures in the bow provided a look-out for the pilot when the submarine was under the water and also enabled the searchlight to illuminate the sea-bed. Immediately behind the look-out compartment was the diving compartment, which, in turn, was succeeded by an air-lock that separated the former from the main hold of the vessel. The diving compartment was filled with compressed air, and the air-lock enabled a person to pass from the main hold to either of the two forward compartments irrespective of whether the diving compartment entrance to the sea was open or closed.

This entrance consisted of a hinged trapdoor in the floor of the compartment, through which the diver passed to the sea-bed. The trapdoor was built in flush with the hull and was opened from the inside of the compartment. When open it was dropped down to the sea-bed and formed an inclined path for the diver to pass along. When the diving compartment was in use the look-out man communicated with his comrades in the main hold of the submarine by means of a portable telephone, and a similar means was utilised by the diver to communicate to the crew.

A very ingenious method was used to effect a descent to the bottom of the sea. The trapdoor in the conning tower was shut down and water admitted to the ballast tanks. Two heavy weights, one fore and aft, and recessed in the keel of the vessel, were then lowered to the sea-bed by means of long cables. When the weights reached the bottom, the motion of the winding machinery in the vessel was reversed. As the filling ballast tanks steadily reduced the buoyancy, the cables were slowly wound in again until the vessel rested upon its keel on the sea-bed and the weights were again accommodated in their recesses.

An extensive survey of the Atlantic coast of America was carried out in this submarine during 1898, approximately 2000 miles being traversed. Later its hull was lengthened by cutting it in two and inserting a new section amidships. As a result of this and other alterations, she was increased to 66ft. in length and 10ft. across in the widest part. A 60-H.P. petrol motor was substituted for the original one. The increased space enabled a greater supply of compressed air to be accommodated, sufficient to enable the submarine to remain submerged for 48 hours.

Although the "Argonaut" behaved well for its purpose, Lake came to realise that the authorities considered that the true purpose of a submarine was that of a war vessel, and so in 1901 he turned his attention to constructing a torpedo-carrying submarine. This new vessel was named the "Protector," and it could travel either on the surface or through the water, and also along the sea-bottom on four wheels which were mounted on what were described as "swinging axles," so that when the wheels were not in use they could be drawn up into recesses in the hull.

The "Protector" attained a surface speed of 8½ knots when propelled by her petrol motors, and a maximum speed of 9·3 knots when driven by both petrol and electric motors. When totally submerged and propelled only by the electric motors she proved capable of a speed of 5·4 knots. Eventually she was sold to Russia and re-named the "Ossetyr."

John P. Holland had none of Lake's peaceable ambitions with regard to the future of submarines, and the type of submersibie boat he invented was designed solely as a war weapon. He was born and educated in Ireland at a time when that country was the scene of considerable discontent and rioting. Whilst a school teacher in County Clare he completed his design and endeavoured to enlist financial aid. But he could not raise sufficient interest or money either in Ireland or America—where he latterly settled in Boston—to carry out fully his designs, and he therefore decided to build as good a submarine as he could with the small funds he already possessed.

This submarine was completed in due course, but misfortune followed it from the start. After being hauled to the Passaic River by a team of horses, it stuck fast in the mud. With considerable difficulty it was launched, and then its defects made themselves very evident, for it leaked alarmingly, and the engine ran so badly that finally he scrapped the complete craft.

But Holland was a man of great determination, and in spite of this set-back he went forward with his scheme. He belonged to a strong anti-British society which financed two further submarines, the second and largest of which was equipped with both horizontal and vertical rudders. In 1895 his design for a submarine to be built by the United States Government was chosen out of a large number of entries. The price agreed upon for the submarine was £19,000, and the construction was carried out by a company organised by Holland, under the supervision of Government engineers. But the latter made so many alterations to the inventor's plans that the vessel proved a failure, and in disgust Holland refunded the contract money and took back the vessel, which had been named the "Plunger."

Another submarine was constructed by his company, this time in strict accordance with the inventor's designs, and was named the "Holland." This vessel established the basis for all the submarines that have since been built. She was of cigar shape, 54ft. in length and 10ft. 3in. across at the widest part, and was of approximately 70 tons displacement when submerged. When cruising on the surface she could attain a maximum speed of 6 knots by means of a 50 H.P. four-cylinder petrol engine, and when travelling submerged she was capable of a speed of 5 knots, propulsion then being obtained by a 50-H.P. electric motor.

She could travel submerged for a period of about four hours, equivalent to a journey of roughly 20 miles, and she carried sufficient fuel for a journey of 200 miles at maximum cruising speed. One torpedo tube was fitted. She proved a great success, and was purchased by the United States Government for £30,000. This historic submarine was in active service until 1910, when it was withdrawn as obsolete and transferred to the Naval Academy at Annapolis.

The efficiency of the "Holland" led the U.S. Government to order seven similar but larger and more powerful vessels. These were each of 120 tons displacement and proved capable of a maximum surface speed of 8½ knots and a submerged speed of 7 knots. The single propeller of each submarine was driven by a 70 H.P. electric motor when the craft was submerged and a 160 H.P. petrol engine when on the surface. They were known as the "Adder" class, and each was equipped with a single torpedo tube and two spare torpedoes.

British Developments

The experiments with submarines carried out in France and America were watched closely by the British Government, and when the success of the "Holland" submarine made it clear that the development of submersible boats had passed from the purely experimental to the practical stage, steps were taken to build up a submarine fleet. Negotiations with the inventor resulted in the British Government obtaining the right to construct submarines of the "Holland" type, and in 1900 the Admiralty instructed Vickers, Sons and Maxim to build five vessels, each of 120 tons displacement.

Their hulls were of steel and of sufficient strength to stand the water pressure at a depth of 100ft., being strengthened by watertight bulkheads and decks. An armoured conning tower, 2ft. 8in. in diameter and 4in. in thickness, was provided for the use and protection of the navigator. Water ballast tanks were provided throughout the length of the submarine as a means of regulating the draught, preserving longitudinal trim, and keeping the displacement weight constant in different waters.

As the use of fuel and torpedoes during a voyage gradually reduced the weight of the vessels, the ballast tanks were filled in sufficient proportion to compensate for the loss. Two vertical and two

horizontal rudders, fore and aft, were fitted for steering and driving purposes respectively. Their single propeller was driven by a 160 H.P. petrol engine when on the surface, and by an electric motor when submerged.

Each submarine was fitted with a periscope, consisting of a vertical tube about 10ft. in height, fitted at the top and bottom with an arrangement of lenses and reflectors. The periscope projected above the surface of the water when the vessel was submerged and gave a clear view of the surrounding objects to the navigator. A liberal supply of compressed air was maintained aboard.

The "Holland" type submarines were speedily followed by the earlier "A" class of British submarines of 100 tons displacement, and having a surface speed of 12 knots and a submerged speed of 8 knots. From this time the development of the British submarine was very rapid. The "B" class were of 50 per cent. greater displacement than the "A" class, and had a speed of 13 knots, while the "C" class were capable of a much greater radius of action than their predecessors.

The "D" class was introduced in 1907 and the "E" class in 1912. The latter were the first British submarines to be equipped with engines running on heavy oil instead of the petrol used in the engines of the earlier types, and this, of course, made them much safer as well as more efficient, and marks a very definite turning point in the development of the submarine. Each "E" class submarine was provided with five torpedo tubes, and the later members of the class also had a 3in. quick-firing gun mounted so that it could be lowered inside the hull before the vessel submerged.

During the Great War the need arose for submarines capable of accompanying the British Fleet on ocean cruises, and this resulted in the production of the "K" class. These were large submarines of 2650 tons displacement. They had steam turbines in place of the ordinary oil engines, and a Diesel engine was installed only for auxiliary surface power.

The first "K" class were constructed with a flush deck, having a superstructure amidships that accommodated two above-water 18in. torpedo tubes. Two anti-aircraft guns were mounted on the hull, one behind the superstructure. Later this arrangement was altered, the torpedo tubes being removed and a navigating bridge screen built up on the conning tower, while the guns were transferred to the superstructure and the bows built up into a bulging form known as a "high clipper stem."

A feature of the "K" class was the two hinged funnels. When the vessel was preparing to submerge, the steam power was used up until exhausted, and then the electric motor was brought into operation. The funnels were lowered into wells, which were then closed by watertight lids. The "K" submarines were 338ft. in length, 26½ft. wide, and 16ft. in depth. Storage was provided for from 200 to 300 tons of oil fuel. Their crew numbered 55.

In 1915 Lord Fisher proposed the construction of a submarine having a big gun mounted on the superstructure. Three vessels equipped in this manner were built, and were known as the "M" class. Their surface speed was 15½ knots. The "Thames" class, of 1850 and 2710 tons, are now our largest. Some submarines now carry aeroplanes as well as guns.

It is interesting to record that the submarine merchantman made her appearance during the Great War in the "Deutschland," which twice safely proceeded to the United States. She cost some £100,000, and was manned by a crew of 29, but she carried only 750 tons of cargo. A sister vessel was also built, the "Bremen." But it is now realised that the submarine is essentially only a weapon of war. The world's largest submarine is the French "Surcouf" of 2880 tons surface displacement. The maximum depth to which a submarine is known to have descended without being crushed is slightly over 400ft.

Press Shearing Through an Oblique Plane

By HENRY C. LANE

THE present heavy demands on milling and broaching machine production forces consideration of other production methods wherever possible. One product that offered possibilities of alternative production is illustrated at Fig. 1. The production order was for comparatively small quantities (160 off the 5in. 3-radii blank and 580 off the 7½in. 4-radii blank) yet the total quantity was considered sufficient to permit a fairly heavy tool cost if milling or broaching could be eliminated.

It was originally intended to produce from bright drawn mild steel on account of its accurate width and to radius-oblique-notch each side separately on a $\frac{3}{16}$in. to allow ample room for the $\frac{3}{16}$in. stock which was expected to take a slight bend in the notching processes. The stripper itself was cut short past the two punch holes to allow of easy feeding of the blanks to be notched.

The operation sequence lay-out in Fig. 2 increased the overall blank length to 10in. and planned the second operation to produce two square notched ends to give a standard working width of 1in. at each end so that the centre line of these 1in. ends should coincide with the centre line of the bar, which might vary from $1\frac{7}{16}$in. to $1\frac{9}{16}$in. in width.

Operation 3 notched one side of the blank when resting on the support blocks A and B (D being removed for this operation) while A was also used as an end stop. For operation 4 the blank rested on support blocks C and D (A being removed for this operation) while the end stop for this operation became E so that the same shoulder of the blank engaged with E in the second operation notch as with A in the first notching.

In operations 3 and 4 the question of stock support was found to be less difficult than originally anticipated since the square-cut leg punches dug well into the metal before actual shearing commenced and themselves acted as supports to such good effect that the oblique surface of the radius notches in the blanks were well burnished.

To save extra experimental costs for further gauge blocks it was decided to produce all blanks originally with four radius notches, subsequently cropping to the required size (3 or 4 radii type) as shown in Fig. 2, Ops. 5A, and 5B. This process presented no difficulties with a simple cropping die and punch provided with the usual legs while gauging was carried out

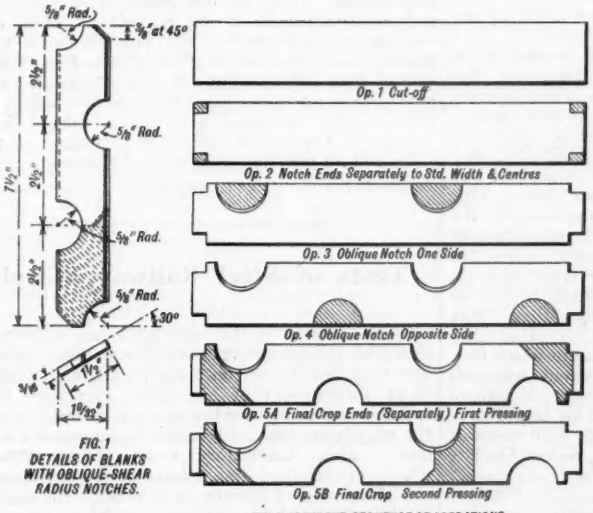


FIG. 1 DETAILS OF BLANKS WITH OBLIQUE-SHEAR RADIUS NOTCHES.

FIG. 2 COMPLETE SEQUENCE OF OPERATIONS. (SHADED PORTIONS REMOVED AT RESPECTIVE STAGES)

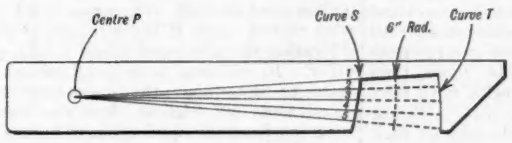


FIG. 5 GAUGING CLAW DETAIL.

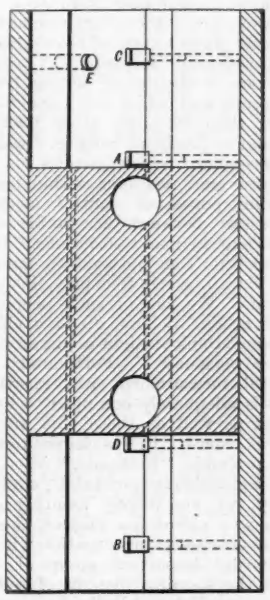


FIG. 3 PLAN & END VIEW OF RADIUS DIE. END STOP & GAUGES "A" & "B" FITTED IN OP. 3 END STOP "E" & GAUGES "C" & "D" FITTED IN OP. 4

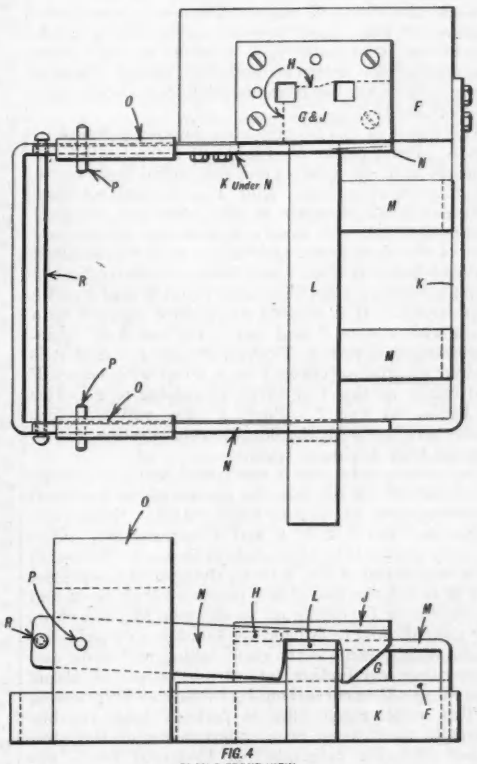


FIG. 4 PLAN & FRONT VIEW SELF-CENTRING NOTCH DIE.

"THE ENGINEER"

from the radius being cut and its companion on the same side.

The tools in Fig. 3 were completed except for support blocks, and tested to ascertain the exact results obtainable from notching somewhat before any final decision had been reached regarding the gauging methods necessary for Op. 2, square notching to standard widths and centres. The results of work on Fig. 3 tools showed it to be essential that the blanks should be worked evenly on each side, since although the bar stock could be angle notched well beyond the full semi-circle, the deeper the notch the greater the difficulties experienced in stripping from the punches.

Eventually I adopted what I believe to be a novel form of gauging for Op. 2 though I have used the same essential principle in a variety of final designs with somewhat less success than we have now attained. A conventional die, gauge, and stripper G, H, and J (Fig. 4), are mounted with edges flush to that of the die shoe F. A strip frame K is bolted to the die shoe and a bar support strip (1¼in. width) L is screwed to the die shoe and riveted by means of an "L" bracket to the frame K so that the upper surface of "L" is level with the die surface. Two additional brackets are riveted to the frame K at M to give an upper surface level with that of L in order to facilitate side feeding of the blanks at die level. The stripper is anchored by three only of the four die screws and the gauge H is cut away to the right for the same purpose of side feeding. Two identical true-gearing claws N are carried in built-up plate frames O on the front and back bars of the frame K. The claws are hinged at P, which are finally located with centres $\frac{3}{16}$in. (bar stock thickness) above die level and 6in. to the left of die centre line produced.

In locating these pivot centres P, it was found simplest to form and finish the complete frames O with claws N assembled on pins P; to clamp a length of 1¼in. by $\frac{3}{16}$in. bright drawn stock on support L in true centre with die, and then by packing end of pins P at the correct height and allowing claws to lock on the bar stock to adjust position of the plate frames O on the main frame K, subsequently clamping and riveting together.

While the claws N remain free-acting and independent, it was found possible to provide a quick release bar R in holes $\frac{1}{16}$in. oversize so that independence of claw action is unaffected, though pressure downwards on the bar R immediately raises both claws clear of the stock.

The detail of the gauging claw lay-out is found in Fig. 5. From centre P is laid out a 6in. radius (to coincide with die centre) and five radial lines are to cut this centre radius. Line 1 is located to leave sufficient final strength to the claw for working purposes and line 5 closely approaches the bottom edge of the claw at its extremity. Line 3 is situated midway between lines 1 and 5, and similarly lines 2 and 4 are situated between lines 1 and 3, and 3 and 5 respectively. It is desired to produce curve S as a scroll with centre P and radius on line 5 of $5\frac{3}{32}$in. increasing to a radius of $5\frac{9}{32}$in. at line 1. And it is desired to produce curve T as a scroll with centre P and radius on line 1 of $6\frac{23}{32}$in. increasing to a radius of $6\frac{25}{32}$in. on line 5. Such a claw will therefore centre any bar with the 6in. die centre radius within a range from $1\frac{7}{16}$in. to $1\frac{9}{16}$in.

In actual production it was found accurate enough to divide off on the 6in. die centre radius balanced measurements of $1\frac{7}{16}$in., $1\frac{15}{32}$in., $1\frac{1}{2}$in., $1\frac{17}{32}$in., and $1\frac{9}{16}$in. on lines 1, 2, 3, 4, and 5, respectively, subsequently joining their outer ends to form curves S and T.

In actual use of Fig. 4 tools, the operator depresses rod R to lift the two claws, places a blank on M and slides it over L holding up to end stop H; the claws are then allowed to fall and the blank is given a lateral shake which results in the claws falling well home and preventing any further lateral motion in the blank. Notching is then carried out by two square leg punches.

This scroll gauge claw is perhaps more troublesome to make than other adaptations of the same taper centering principle. A U-shaped frame can be hinged by its arms at any level, transverse to the bar centre line (not longitudinal to bar centre as in this case) and in such a case the gauging slot in the base of the U-shaped frame would be a simple true angle V, but it would be difficult to attain the same rigidity to gauging slot that is obtained in the present method where the general framework carrying the pivot pins is amply braced to the die shoe itself.

Production rates on the whole job illustrated at Fig. 1 are somewhat naturally below those of straightforward press-work, yet Op. 3 at 59 mins. per gross pieces and Op. 4 at 46 mins. per gross pieces are inestimably faster than milling in gangs. The complete time record shows that self-centering gauges and their operation more than pay for themselves in eliminating the heavy material cost of bright drawn M.S. stock—the time record given below is for one gross pieces of either the first or second pressing:

Operation No. 1	28 mins.
Operation No. 2	58 mins.
Operation No. 3	59 mins.
Operation No. 4	46 mins.
Operation No. 5 A or B	40 mins.
Total	231 mins.

Average production time per complete piece, 1 min. 38 seconds.

Measuring Personality

By GUY W. WADSWORTH, JR.

MEASUREMENT of personality or temperament is of interest because success so frequently depends upon adjustment of the worker to fellow employees, and to the working environment, rather than strictly upon technical skill. When supervisors are permitted to analyse success or failure in their own words, their most frequent comment has to do with the worker's habits, attitudes, co-operativeness (or lack of it), and disposition to perform up to his capabilities. There is considerable evidence that successful adjustment to a job calls into play much of the same abilities as those which enable an individual to adjust to a social situation of any kind. There is no essential difference between misunderstandings among employees and those which occur in any other situation in which people get together. A working relationship, in which employees rub noses daily under force of economic necessity, would logically require fundamental compatibility far beyond that needed in casual social contacts, which we can take or let alone. People do not "settle their differences off the job." They merely endure them until some pent-up resentment gets out of hand. Then we have a "labour problem."

Whenever we mention personality, our most immediate association is with "How to Make Friends and Influence People," or we think of the last salesman whose winning ways induced us to buy something we did not want. Just as we have been quick to accept systems for sizing-up people, some of us jump at methods of changing and improving personality. Actually, the scientific study of human behaviour has gone little beyond the painstaking identification of a few characteristics and efforts to describe their effect upon our conduct. Personality measurement deals with tendencies and predispositions but offers no panacea for undesirable faults. The thesis merely is that, if we can determine the basic reaction pattern within which our impulses operate, we can predict behaviour. We start with diagnosis, so that we can distinguish good risks from poor ones. We do not yet know much about how to effect a cure.

At its present state of development, personality or temperamental measurement can determine the presence or absence of certain traits which operate in groups and which are important to job success. First, there is a group of traits associated with self-control, rational balance, durability of mind, and conservatism, which enables us to maintain our impulses and reactions within normal limits. This braking power or control mechanism spells the difference between acceptable and unacceptable behaviour in many situations. Without reasonable self-restraint, an individual's temper runs wild, his hatreds are given free play, his egotism knows no bounds. We say of such people that they "lose their heads," "blow up in a crisis," or that they "cannot think straight about anything in which they figure personally." Fortunately, current temperamental measurement can identify the individual who is adequately equipped to hold his impulses in check as well as those who are not well-endowed in this regard. In less elegant terms, we can identify the probable "hotheads," often the "soreheads," and sometimes the potential "swell heads." "Essentially, we are merely assuring ourselves that the man who enters our employ can adjust himself to the average working situation without fuss or fury.

Another important group of traits is associated with the so-called instinct of self-preservation. All of us are selfish and inclined to serve our own interests to some degree. Certain individuals, more than others, will not move out of their tracks, until they see what they are "going to get out of it." People whose self-concern gets out of bounds achieve their own purposes at the expense of the other fellow, or of society in general, if need be. They are willing to ride on the efforts of fellow workers. In some instances, they become anti-social and lacking in compunction. On the job, supervisors say that they "look for the easy things to do," complain that they "hang back," and merely do enough to "get by." Sometimes anti-social characteristics are carried to the point of cheating, lying, wheedling, scheming, and malingering. The fundamental difficulty is that the ethical sensibilities and the sense of social responsibility which is normal to mature human beings have remained undeveloped. Such individuals have juvenile minds and refuse to grow up. The attitude is infantile, whether it exists in a small child or in a man 40 years of age. There is trouble waiting at the crossroads for any group which includes individuals in whom these traits predominate. They do not fit into organisations where reasonable willingness to work is an essential.

A third group of traits which can be measured has to do with the emotions, and particularly with the "highs" and "lows" experienced when people react to situations, and to other people, as they happen to feel at the moment. Where emotionality is marked, the individual tends to be either "shouting to Heaven," or "grieved to death." They are about to "take the town by storm," or "all is lost save honour." Among salesmen, these characteristics elicit the comment that "he goes great guns when he's hot, but you have to light a fire under him every Thursday." In ordinary occupations, the hyper-emotional individual only does his best work when he "feels right." Those associated with him can only pray that all of the stars will be in proper conformation when his ability is most needed.

All of us are emotional to some degree, but extremes of emotional fervour, whether of elation or depression, merely illustrate the old adage that "what goes up must come down." Temperamental measurement enables us to identify the individuals in whom wide variations in the emotional set may be expected. They are likely to be a total loss in the slow, plodding, methodical occupations. A person moderately endowed with emotionality is an asset in meeting the public, because most of them like people. Their friendliness is an asset to the employer. Their extremes of excitability and pressure of activity are the chief drawback.

Two groups of introvert traits of opposite character can be measured. One is noted in the shy, retiring, and bashful individual who is "all right if you know him," but who is very hard to know. Such individuals tend to suspect others of not thinking well of them, look for social rebuffs, and feel pitifully inadequate in dealings which involve getting along with other people. They personalise experience, indicating beliefs such as: "God sent the rain to spoil my new hat," or "I will not go to see my school play football, because they always lose when I attend the game" (and believe it, mind you). They succeed in such work as inspectorships, or other individual undertakings. They are steady-going and able to concentrate effectively. Temperamental measurement enables us to identify them and to keep them out of assignments in conflict with their fundamental make-up.

The other type of introvert is the person who, on the basis of arrogance, conceit, and contempt for the opinions of others, sets himself apart from his fellows, feeling that the average person is neither interesting nor worth while. Such individuals are often intolerant and argue "at the drop of a hat." They are of value in any line of work calling for persistence and constancy of purpose, even when their job is not a popular one. They are the crusaders, campaigners, and avowed friends of the underdog. Often convincing in their oratory, the pay-off comes when there is close examination of the personal and human side of their partisanship. In many instances, they have no use for the people for whom they argue, but only in the rhetorical possibilities offered by a "cause." Their chief value lies in ability to take sides and to hold on, long after the average person would quit.

Tests of Steel Railway Wheels

STEEL wheels of different kinds are used extensively on the passenger cars of American railways, and to a less extent on freight cars, and with the rapid development of high-speed passenger trains and the increasing speeds and loads of freight trains, the wheels are being subjected to increased stresses and strains. Laboratory tests on wrought-steel wheels of standard design have been carried out at the University of Illinois to determine the strength of the wheels under different conditions of loading and the distribution of strains under vertical loading and horizontal flange loading or pressure. Both carbon-steel and silicon-manganese alloy-steel wheels were tested, since if the strength is the main consideration the alloy-steel wheel might supersede the other. In addition to tests of strength, there were tests to determine the resistance to heat, the co-efficients of friction, and the thermal stresses resulting from the application of brakes to the wheels revolving at high speed. Study was made of the strains developed at different parts of a wheel being pressed upon its axle, with a tolerance of 0·008in. between the diameter of bore and axle. Vertical loads were applied up to a maximum of 300,000 lb. and with a vertical load of 60,000 lb.—or 30,000 lb. on each wheel—horizontal thrusts of 20,000 lb. to 60,000 lb. were applied to the flange at the point of contact with the rail. In a final test to determine the damage resulting from heavy static overload, a vertical load reaching a maximum of 550 tons was applied. None of the vertical loads produced strains that would be considered damaging, even if repeated many times. But a much more serious condition was produced by combined vertical loads and lateral flange loads of about twice the magnitude that could be expected in service. Thus it is probable that the most damaging stresses in service are those caused by the lateral pressure on the flange at turnouts, points, and transition curves. Excessive loading or localised heating due to application of the brakes may develop a new state of residual stress on the wheel.

CHILDREN'S ALLOWANCE.—We are informed by the Glacier Metal Company, Ltd., that as from March 1st the wages of married employees will be supplemented by a weekly payment of 3s. for each child in the family in excess of the first two. This supplement will be paid till the child reaches the age of fifteen years.

Rail and Road

VOLK'S RAILWAY AT BRIGHTON.—In a report to the Council, the Brighton Transport Committee said that an offer had been received from Magnus Volk, Ltd., for the continued management by the company of Volk's railway after March 31st next on a percentage basis plus £500 towards the rates. It was recommended by the committee that the agreement should not be extended, but that the transport manager should be asked to report as to his proposals for the operation of the line by the Corporation.

RAILWAYMEN'S SUGGESTIONS.—War-time conditions have given a new angle to ideas submitted by railway employees under the L.M.S. Railway Company's Staff Suggestions Scheme, which since its inception has yielded nearly 28,000 suggestions for the more efficient and more economical conduct of railway business. The thousands of staff suggestions investigated cover every aspect of railway business. Every suggestion, whether practicable or otherwise, is acknowledged by a letter of thanks, and where suggestions are adopted leading to greater economy or efficiency, or both, monetary awards are made.

SPECIAL COAL TRAINS.—In order to overcome the scarcity of coal which is being experienced in the south of England, as a result of the dislocation of traffic during the recent cold spell, it was announced in the House of Commons, on Wednesday, February 21st, that 143 additional coal trains will be placed in service to enable an increase of about 70,000 tons of coal a week to be carried directly to London and the south. In order that these special trains may be run a number of the regular passenger train services are being curtailed. Special measures are also being taken to augment supplies to public utility undertakings.

AUTOMOBILE LUBRICANTS AND PETROL WASTAGE.—In a note on the widespread demand for light winter oil which has been created by the recent cold weather, *The Autocar* says that the Wakefield Company points out that easy starting from cold is by no means the only advantage thus gained. Tests conducted over a year ago demonstrated that at least 10 per cent. of the petrol used is wasted by the use of too heavy a lubricant. This is because it requires as much power to drive the engine as to drive the car at moderate speed, as a large proportion of the work of rotating the engine consists of shearing the oil films. The British results are confirmed by the American engineer, Mr. S. W. Sparrow, of the Studebaker Corporation. In a contribution to the S.A.E. Journal he published graphs which show that when using too heavy an oil petrol consumption is increased by 16·9 per cent. at 30 m.p.h., 13·8 per cent. at 40 m.p.h., and 11·6 per cent. at 50 m.p.h.

LONDON TRANSPORT STAFF CHANGES.—The London Passenger Transport Board announces the following appointments in the Department of the Chief Engineer (Civil). Mr. H. J. Green, assistant chief engineer, is appointed deputy chief engineer and will be responsible to the chief engineer (civil) for the work of the Building Department, Permanent Way Departments, Civil Engineering Drawing Offices (except new works) and the construction of the Board's Air Raid Precautions work. Mr. J. H. Condy, civil engineer—maintenance—is appointed assistant chief engineer and will be responsible to the chief engineer (civil) as the co-ordinating officer for administrative and staff matters, and the estimating and costing work of the department. The co-ordination of the new works' programme and questions regarding ventilation will also be his responsibility. Mr. J. W. Carswell is appointed an officer of the Board with the title of chief resident engineer.

THE LATE WILLIAM DOUGLAS BELL.—Railway engineers will learn with regret of the death last week, at his home, Craigview, Prestwick, of Mr. William Douglas Bell, who for many years had been the managing director of Andrew Barclay, Sons and Co., Ltd., of Caledonia Engineering Works, Kilmarnock. Mr. Bell was born in Glasgow, but was brought up in Prestwick and was apprenticed with an Ayr engineering firm. In later years he became a director of Duncan Stewart and Co., Ltd., of London Road Ironworks, Glasgow, a position he held for some years until 1908, when he was appointed the general manager of Andrew Barclay Sons, and Co., Ltd., of Kilmarnock. A few years later he became director of the firm, a position which he had held with distinction until his death. Apart from his interests in railway engineering and locomotives Mr. Bell found time for local work, and for some years he was a member of the Ayrshire Education Committee. He was particularly interested in the development of technical education, and was a former chairman of the Kilmarnock Science Committee.

NEW CONSTRUCTION ON THE CHICAGO, ROCK ISLAND AND PACIFIC RAILROAD.—A particularly interesting piece of construction, completed last year on the Chicago, Rock Island, and Pacific Railroad, is described in detail in the *Railway Age*. It comprises the Arkalon cut-off on the Chicago–California main line, which involved the construction of nearly 8½ miles of new line, on fill sections up to 95ft. high, and the building of a new five-span high level bridge 1269ft. long across the valley of the Cimarron river. It replaces a 12 miles long section of line which passed through the valley, the physical features of which presented a severe handicap to efficient operation where there frequently occurred costly washouts of the line. Long fills in the valley on each side of the bridge range from up to 95ft. high and are flanked by deep cuts extending to connections with the main line. The cut at the east end is about 3½ miles long, with depths ranging between 40ft. and 60ft., and that at the west end about 2 miles long with a maximum depth of 30ft. The east fill, 6600ft. long, has a maximum height of 85ft. and the west fill 7200ft. long has a maximum height of 95ft. In order to protect against the spread of fire along the deck of the bridge, it is divided into panels, every other one of which is faced on top with sheet metal which covers all the sleepers and extends continuously between them. An automatic electric fire alarm notifies the signalman when fire breaks the protecting circuit and the approach signals are at the same time set at danger.

Miscellanea

THE INSTITUTE OF EXPORT.—At the annual general meeting of the Institute of Export, Sir Patrick Hannon was unanimously re-elected President for the second consecutive year. Mr. R. J. Turner was re-elected chairman of the council for the sixth consecutive year. Mr. G. T. MacEwan was re-elected vice-chairman of the council for the third consecutive year, and Mr. N. R. Crute was elected treasurer of the Institute, in place of Mr. T. H. Thatcher retired.

UTILISATION OF NATURAL HOT SPRINGS.—Reykjavik, the capital of Iceland, lies in a region of hot springs, and a scheme is in hand whereby the hot water is to be tapped and distributed by a network of pipes, over nine miles long, to the houses and industrial establishments in the city. At the source, the water has a temperature of about 194 deg. Fah., and it is estimated that the loss of heat in pumping will not be over 41 deg. Fah. The hot water will be used for all purposes except cooking and drinking, because of its sulphur content, and the scheme is expected to save some 34,000 tons of coal a year.

SMALL FIRMS AND WAR CONTRACTS.—The Federation of British Industries has been informed by the Ministry of Supply that one of the objects of a new area organisation in Great Britain and Northern Ireland is to bring increasingly into production some of the available engineering capacity of smaller industrial establishments. It is proposed to examine the offers of capacity of all those firms who wish to be considered for munitions production through the medium of area advisory committees, and area boards which are to be set up. The Federation has agreed to assist the Ministry by inviting its local officers to render what help they can, in an advisory capacity, to the secretaries of the area boards, which are the channel to the committees for the reference of all offers of capacity.

EXCLUDING DIRT FROM MOTORS.—In a soya bean mill in the United States, the oil laden vapour and dust around the oil extractors caused a muddy deposit in the motors which not only clogged their air gaps but proved detrimental to their insulation. In order to avoid the expense of installing new completely-enclosed motors it was decided to use a ventilating system that would pass clean air through the motors under pressure, to exclude the dust and vapour. A sheet metal housing was built round the ends of the six motors concerned and connected up to a common overhead duct. Filtered air from outside the building was forced through the duct by a centrifugal blower and into the motors. Access to the motors for inspection purposes was made possible by caps on the housings and grease fittings for the motors were extended out through the caps for convenience.

TRADING WITH THE ENEMY.—The Board of Trade has issued an Order, under which traders, shipowners, and others are warned that it is now unlawful to transact business, or to have other dealings with any person specified in the Order, without permission from the Trading with the Enemy Branch (Treasury and Board of Trade), Alexandra House, Kingsway, W.C.2. Correspondence with enemies on business matters will be permitted in approved cases, but communications will not be passed by the censorship authorities except with the prior approval of the Trading with the Enemy Branch, or, in the case of communications regarding patents, designs, or trademarks, with the prior approval of the Patent Office. Persons who desire to communicate with an enemy on business matters should therefore forward the communication to the Trading with the Enemy Branch, or to the Patent Office (enclosed in a stamped, open envelope addressed to an intermediary in a neutral country), under cover of a letter explaining the circumstances in which it is desired to send it.

MAINTENANCE SCHOLARSHIPS IN ARCHITECTURE.—The Architects' Registration Council of the United Kingdom offers for award in June, 1940, certain Maintenance Scholarships in Architecture. The scholarships will consist of a grant for the payment, in whole or in part, of the school fees and necessary subscriptions, instruments, books, &c., and, when necessary, a maintenance allowance not to exceed as a rule £100 a year. The scholarships will be renewable from year to year until the student has finished school training. They will be available for students of British nationality who could not otherwise afford such training to enable them to attend architectural schools approved by the council. The scholarships will be available both for students who have already begun their training and for students wishing to begin their training. They would not normally be granted to students under 17 years of age. Particulars and forms of application may be obtained from:—The Secretary to the Board of Architectural Education, Architects' Registration Council of the United Kingdom, 68, Portland Place, London, W.1.

PROTECTION OF STAINED GLASS WINDOWS.—In order to protect a stained glass window at the Harpenden Methodist Church it was covered on the outside by a strong splinter-proof box. It was decided to introduce a lighting scheme which would avoid the blacked out appearance of the window from the interior of the church. A scheme was evolved by the well-known illuminating engineers, Holophane, Ltd., which restored the normal daylight effect through the window. The interior of the box was finished a matt Chinese white colour and a special reflector of prismatic design in turquoise blue glassware called "Correctalite" was used. It was found that the correct degree of colour rendering was achieved by the use of these reflectors as it was important that no lamps should be seen by the congregation inside the church. Perfect diffusion was necessary, but this problem was at variance with the requirement that certain sectors of the window, which were darker than the rest, demanded a higher intensity of lighting. These dense portions were treated by additional reflectors of a concentrating type placed so that the "cut off" from the reflectors was adjusted to a line which could not be seen from inside the church. Ordinary gas-filled lamps of 150 watts were used because their spectrum curve in conjunction with the "Correctalite" glassware gave the nearest approach to a daylight view when the sky had normal diffusing clouds.

Air and Water

THE ATLANTIC AIR MAIL SERVICE.—It is reported that plans are well advanced for the resumption of this country's North Atlantic air service to Newfoundland, Canada, and the United States.

PENZANCE HARBOUR IMPROVEMENTS.—The borough engineer of Penzance has prepared a scheme for the improvement of the harbour and tenders are being invited for the deepening of the entrance to the harbour, dock, and floating dock.

BELGIAN PURCHASE OF AMERICAN LINERS.—The United States Line has sold eight liners to the Belgian Company, Société Maritime Anversoise at a reported cost of four million dollars. The vessels include the 13,869 ton "President Harding," five of 7430 tons, one of 7590 tons, and one of 7555 tons. They are to be placed in service between New York, Belgium, the United Kingdom, and France.

PURCHASE OF AMERICAN AIRCRAFT.—The New York correspondent of *The Times* reports that the British and French Purchasing Commissioners have decided to order in the United States all the aeroplanes the manufacturers will agree to make for them after meeting the needs of the United States Government and commercial aviation. This step is expected to involve the placing of orders to a total value of up to 250 million pounds.

MOTOR LAUNCHES FOR MINE SWEEPING.—Four motor launches have been ordered by the Dutch Government for mine sweeping service. The launches are being built by G. de Vries Lentsch Jr., and will have the following dimensions:—Length, 70ft., breadth, 14ft. 9in., draught, 3ft. 7in. They will be propelled by two eight-cylinder Gardner Kromhout oil engines, each of 102 B.H.P., to give a speed of ten knots while sweeping.

A NEW LIFESAVING SUIT.—A Swedish engineer has developed a new lifesaving suit which not only keeps a person afloat, but protects him from direct contact with the water and may be worn as an overall in danger areas. It comprises suit, boots, and mittens all in one, and is easily put on. It is made of waterproof rubber, closed in front by a "zip" type fastener and is made buoyant by a Kapok lined waistcoat integral with the body of the suit.

AMERICAN TRANS-ATLANTIC AIR SERVICES.—It is announced that owing to a better weather reporting service being made available by the United States Government, Pan-American Airways has decided that its trans-Atlantic clippers will not stop at Bermuda on eastward flights. The American Government has placed two vessels in mid-Atlantic for the purpose of reporting weather conditions, and in the future machines will fly direct to Horta in the Azores.

AERONAUTICAL RESEARCH IN AMERICA.—The annual report of the United States National Advisory Committee for Aeronautics states that there is a serious lack of engine research facilities in the United States, and that immediate steps should be taken to remedy the deficiency by the establishment of research laboratories for this class of work. The committee called attention to the fact that the reason for foreign leadership in certain types of military aircraft is due in part to the superiority of foreign liquid cooled engines.

EQUIPMENT FOR THE PROTECTION OF MERCHANTMEN.—An order issued by the Admiralty states that no ship registered in the United Kingdom whose owners have been or may be notified by the Admiralty that they will be required to provide protection on board their ships for personnel exposed to machine-gun attack by enemy aircraft is to proceed to sea, except under permission, from any port in the United Kingdom, unless equipped with special protective equipment. The nature of the equipment to be provided has been or will be notified to shipowners from time to time as may be found necessary.

READY RECKONER FOR PORT AND OTHER CHARGES.—The Port of London Authority has prepared and published a ready reckoner for port charges. The tables are designed for the rapid computation to the nearest penny of prime and rent charges, based on weight, at basic rates from 3d. to 33s. 4d. per ton. A preface to the reckoner gives directions, amplified with examples, for the use of these tables. While the tables have been prepared primarily for the use of the staff of the P.L.A., they are not limited in their scope or application to the calculation of port charges. Copies may be obtained from the Press Officer, Port of London Authority, Trinity Square, E.C.3.

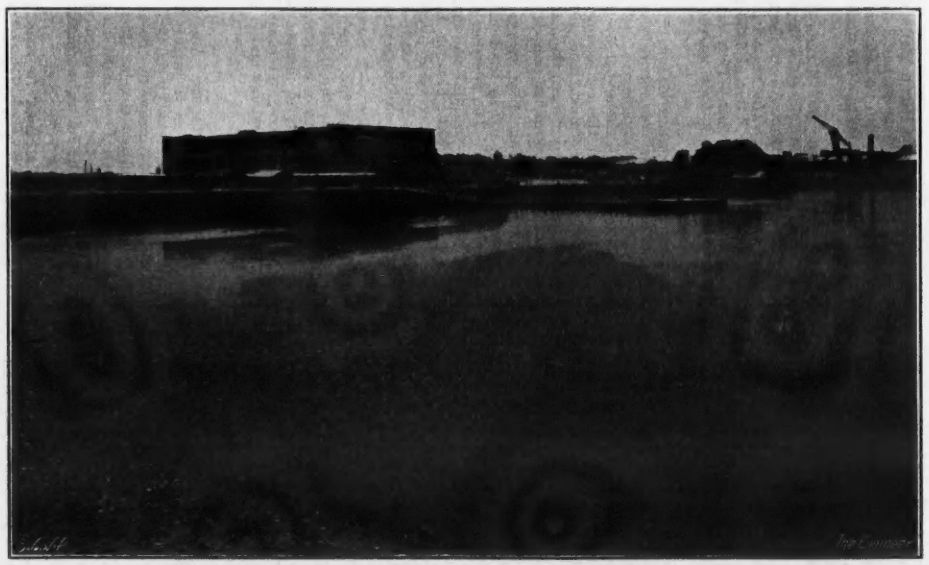
JAPANESE SHIPPING BUDGET.—In its budget for 1940–41, the Ships Control Bureau of the Japanese Ministry of Communications proposes the opening of a service between Japan and New Caledonia on which 5000-ton liners will maintain a monthly sailing schedule. A temporary training institute for sailors is to be established in two places, each institute to graduate 300 officers a year. The number of students enrolled at present in the 40 existing training schools for ordinary seamen is to be doubled so that each school will accommodate 120 students. A subsidy is to be granted for interest on loans for shipbuilding funds to encourage shipbuilding. A subsidy is also to be granted for the construction of cargo vessels.

A POWERFUL AMERICAN FIGHTER MONOPLANE.—An illustration and brief particulars are given in *Flight* of the Bell P.39 fighter monoplane which is officially stated to have a top speed of over 400 m.p.h., a ceiling of over 36,000ft., and a cruising range of more than 1000 miles, the cruising speed being about 325 m.p.h. The all-up weight is about 6000 lb. An Allison vee-twelve engine is mounted in the fuselage behind the cockpit and drives a three-bladed Curtiss airscrew through a shaft. The engine and its shaft drive have been tested for more than 500 hours. At its widest point the fuselage is only 34in. It has a retractable tricycle undercarriage, and its overall dimensions are span, 34ft., and length 29ft. 9in., the wing loading being 28·3 lb. sq. ft. A 37 mm. shell-gun fires through the airscrew hub and there are four synchronised machine guns in the fuselage.

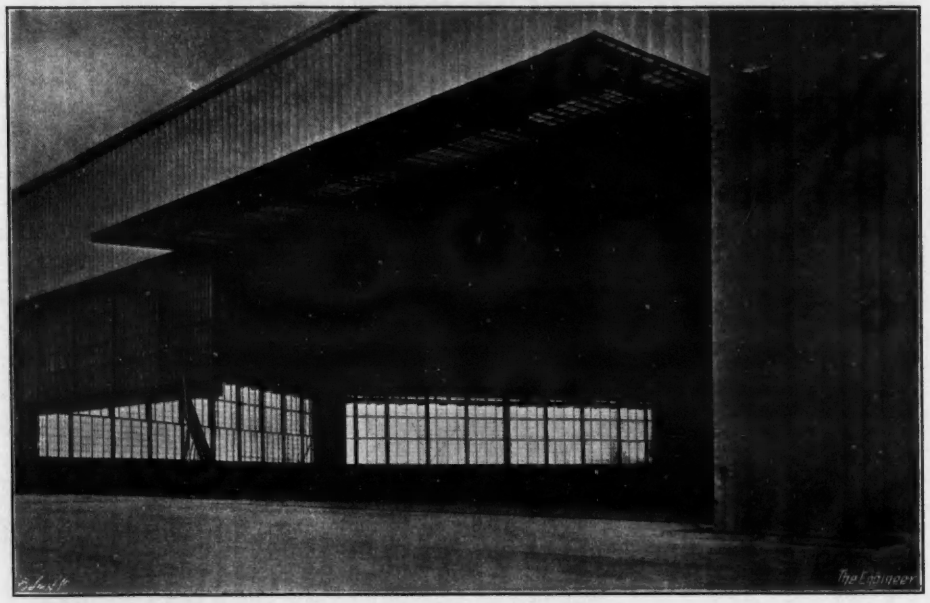
NEW YORK MUNICIPAL AIRPORT

(*For description see page* 198)

LANDWARD SIDE OF SEAPLANE HANGAR



SHORE FRONT OF MARINE TERMINAL



SEAPLANE HANGAR WITH DOOR OPEN

INTERIOR OF SEAPLANE HANGAR

The Engineer

MARCH 1, 1940

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WAR MEASURES

PUBLISHING AND ADVERTISING

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GENERAL

The head office, 28, ESSEX STREET, STRAND, W.C.2, is open from Mondays to Fridays inclusive from 9-15 a.m. to 5-15 p.m., where classified advertisements may be handed in as usual and copies of the paper may be purchased. The office is not open on Saturdays.

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With a view to the conservation of paper, readers are advised, in the interests of all concerned, to place a regular order for THE ENGINEER with their newsagent or direct with the Publisher.

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*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

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ECONOMIC WARFARE

To ensure our ultimate victory in the bitter struggle in which we are involved every available weapon must be developed and used fully and relentlessly. Our armed forces naturally occupy the centre of the stage in the great drama of war which is unfolding itself before our eyes, but even they must not be permitted to overshadow the importance of the economic arm. The financial, industrial, and commercial resources of the British Empire far exceed those of the enemy, and if they are fully mobilised, and remorselessly applied, they must become irresistible. The scope of our economic power extends both directly and indirectly to every aspect of war, for not only do our armed forces depend on our industrial output for their equipment and supply, but our revenue is drawn mainly from the same source.

Economic power is exercised broadly in two main directions: positively by supplying our own needs, and negatively by depriving the enemy of his essential requirements. The full application of our economic power depends on the Navy, which keeps open the sea routes for our outgoing and incoming traffic, and which closes them to the traffic of the enemy. Imports we must have, for much of our food, and raw material, and many of our munitions necessarily come from abroad, and the foreign exchange to pay for them can be obtained only from the sale of our foreign securities (which are much less than when the last war broke out), from the earnings of our shipping and other services, and from the proceeds of our export trade. The effects of export trade are many and are all to our advantage; for it produces exchange to liquidate our foreign liabilities and actually influences the rate of this exchange in our favour. Already we have paralysed Germany's sea-borne commerce, both import and export, except in the Baltic, but she still has access to many overland sources of supply, with which we at present are unable seriously to interfere, and she is still exporting manufactured goods in astonishing quantities. But we can attack German trade in the countries still open to her by buying all the useful products we can obtain from them, thus reducing supplies available for Germany and putting up the price against her. By selling in these markets all the Empire products which are available we provide exchange to pay for our purchases, while by reducing the demand for German goods we deprive her of her foreign exchange, of which more than anything else she stands in urgent need. Many classes of Empire and British products are still available for export and the home consumption of these goods should be reduced to the lowest possible levels, with the object of further increasing our exportable surplus. In most branches of engineering, however, the war demand still greatly exceeds present production and this demand increases daily. Government restrictions have been imposed on the export of most of these essential products. In the circumstances this is sound policy, for first things must come first. The deplorable fact is that our output of engineering goods is still far less than the maximum attainable, even with our existing plants, for more than half of our machinery still lies idle at night. If our night-shifts were brought up to full strength, or if the three-shift system, which is even better, could be adopted, supplies would be increased to such an extent that besides meeting our war demand some surplus for export would be created. If one takes the short view, it may be argued that export trade must wait until the home demand has been satisfied. But the short view is generally the wrong view, and in this case it is very wrong indeed. Foreign buyers, even when they are accustomed to British goods and prefer to buy them, cannot and will not wait until it suits our convenience to supply. So, perforce, they turn to other exporting countries, which are only too delighted to capture from us the foreign markets in which we have built up invaluable connections and goodwill through years of effort. It is hard enough to establish these connections, but very easy to interrupt and destroy them, and almost impossible to recapture them when our competitors have become firmly entrenched. America, Italy, Switzerland, and Belgium are actively attacking our foreign markets, and Germany, who has organised her resources far more effectively than we have done, is still exporting large volumes of manufactured goods and engineering products.

What can we do about it in our present difficult circumstances? The answer is clear: we too must organise and increase our output. How can it be done? The answer is equally clear: nothing prevents an almost immediate increase in production, except our difficulties (through the maintenance of peace-time restrictions) of obtaining adequate labour to operate our existing machinery continuously, instead of allowing more than half of it to stand idle at night. War is a great disorganiser: while it overwhelms certain trades with floods of orders, it creates large-scale unemployment in others. Much of this unemployed labour can find remunerative work in those trades which are under-staffed, and if facts are faced and hampering restrictions removed, full night-shifts can quickly be built up. But the objection is raised that unemployed labour has not the ability to engage in trades other than those with which it is familiar. This objection has been proved again and again to be completely without foundation. For, after a few weeks of training, anyone of even average intelligence can perform most of the simple repetition work which abounds in all modern engineering shops. Skilled labour is no longer available; it is all employed, but much of it is engaged on work entirely unworthy of its skill, and if the principle of dilution is fully accepted this skilled labour can concentrate on the exacting jobs, which it alone can satisfactorily perform. Surely the emergency is sufficiently urgent to justify a full measure of sacrifice of peace-time restrictions by the temporary abandonment of which the war can not only be won but, what is more, won quickly, and thousands of lives and millions of pounds of treasure can be saved.

Personality in Business

IF there is one thing more than another that Americans enjoy it is all that may be summed up in the single word "personality." It is only necessary to compare their technical press with ours to see that. One rarely comes across a number in which there are not several portraits and it often happens that portraits of individuals and groups of individuals seem to occupy the major part of the editorial pages. It is not difficult to see in this fact an avowal of what everybody knows—that in ninety-nine cases out of a hundred it is the man inside or behind the expert who counts. People who talk about rewards by merit are very prone to overlook that elementary fact. They think that the man with the highest technical qualifications should always be given the highest position, entirely forgetting that unless he has also those peculiar properties which enable him to influence others, to draw them towards him, to make friends of them, or to hold them together as a united force, his qualities, howsoever great they may be in the technical field, will not help him to guide the kind of affairs upon which the business of the world depends. It is through the doing of things that the world gets on, not by the thinking about them; and as doing involves sooner or later engaging the help of others, the men with that almost indefinable quality which we call personality get to the top. Sometimes they are rogues who cheat the world, more often they are great commanders or, in industry and business, pioneers, most often they are just ordinary men who have the knack of co-ordinating the work of their fellows and securing their co-operation.

On another page we extract a section from a paper written by Mr. Guy W. Wadsworth, Jnr. for the American Society of Mechanical Engineers. Mr. Wadsworth is described as the personnel manager of the Southern California Gas Company, Los Angeles. Personnel managers are hardly known in this country. The work they do in America is supposed to be done here by the works manager or the directors or by the welfare superintendent. "Unless the personnel man," says Mr. Wadsworth, "can select better workers

than would be hired by department heads, and deal more efficiently with promotions, transfers, and like problems there may be no special virtue in centralising personnel functions." Here we rely on personal impressions backed up by enquiries and a "character" or its equivalent. There is nothing scientific about our method; we do not attempt to submerge our feelings and measure the candidate against some established standard. We confess for our own part that we like to be guided by our personal impressions. We have more faith in them than we have in schedules and capacity tests. We dare say we are not more often misled by superficial effects than the "personnel man" who makes a life work of selecting round pegs for round holes. Even he must sometimes pick an octagon, or a hectagon, or a square, and then he has to do just what the rest of us do, confess, after due trials, that the appointment was a failure, and begin again. Mr. Wadsworth himself admits that "the scientific study of human behaviour has gone little beyond the painstaking identification of a few characteristics and efforts to describe their effect upon our conduct," but he leans towards the view that "if we can determine the basic reaction pattern within which our impulses operate, we can predict behaviour," which seems to be equivalent to saying that if we know why a man does a certain thing we know why he does it. Certainly it does not take us much further. It may be very interesting to know that N. or M. was soured in his youth by a blighted love affair and has remained sour ever since, but the knowledge does not help the employer who is looking for a sweet tempered traveller to deal with recalcitrant customers. It is not improbable that the ordinary way of picking the right man for that job would be at least as fruitful as the scientific method.

But, its scientific application apart, Mr. Wadsworth's review of the traits by which personality may be investigated, if not measured, are interesting in themselves. We all know the characteristics which the author describes and would perhaps reach the same conclusions about them that he does, though we should fail to express them so pithily or so wittily. As for example:—"They," the self preservationists, "do not fit into organisations where reasonable willingness to work is essential," or, "Those associated with him," the emotionalist, "can only pray that all of the stars will be in proper conformation when his ability is most needed." But we are in much doubt that "temperamental measurement" is necessary to distinguish the "God-sent-the-rain-to-spoil-my-new-hat" sort of person, male or female, or the introvert who "sets himself apart from his fellows, feeling that the average person is neither interesting or worthwhile." In any case it seems that nothing can be done about it. The psychologist sets down scientifically what we have all been doing all the time without the blessing of Science, but he is no better off than the rest of us when it comes to improving matters. As a doctor he can tell you scientifically that you have a headache, but he can't tell you how to get rid of it. All he claims, when you are looking for personality, is to be able to separate the good risks from the poor ones. Which leaves us very much where we were, namely, that personality is an inscrutable something that some people have and some have not.

Importation of Machinery and Parts

By PETER BOUSFIELD

As the majority of engineering firms are no doubt already aware there have been introduced in two stages Orders to operate for the limitation of goods being imported into this country. It is the intention behind this article to study briefly the regulations, their effect upon the machinery importer, and finally a general criticism which in all fairness must necessarily be a severe criticism of the way in which these restrictions—or rather "prohibitions"—have come about.

The Two Prohibition Orders

The first Prohibition Order was introduced towards the end of last October. This affected a great variety of imports related to many trades; but this article is concerned with the engineering standpoint and it will thus suffice to mention that importers of machinery and machinery parts were faced with a very large list of "prohibited" goods. It would be simpler to give a list of the exempted goods than to survey the all-embracing nature of the Prohibition List.

On January 1st, 1940, the "Consolidated Prohibition Order" became immediately effective. As the name implies, this was a filling up of the few gaps that remained and meant that all machinery could be refused admission to this country unless a licence to import it had been already obtained.

What the "Orders" Entail

The October Prohibition Order was met with consternation on the part of importers in general. It was so sudden and so ruthless a blow at the importer than the first reaction was one of stunned dismay; but later the importer of machinery and machinery parts allowed indignation to mingle with his other feelings. However, the facts had to be realised and machinery importers began each to tackle the problem from their own angle.

A visit to the Import Licensing Department provided the importer with a supply of licence application forms and the formidable list of prohibited goods. The application form contains over twenty questions of a not very encouraging nature. Amongst other things the would-be importer has to state any reasons he can give against the equivalent machinery being manufactured in Great Britain, which entails also a description of how his machinery differs from or is an improvement upon the British equivalent—if there is an equivalent.

To go over the questions on the form would be an unnecessary process, especially as most of those who are interested enough to read this article are no doubt aware of what the unpleasant form contains. To sum up the questionnaire it can, however, be said that it gives the importer little reason for hoping that his request for a licence will be acceded to.

Methods of the I.L.D.

Familiar as the machinery importer may be with the application form, he is probably not equally conversant with the methods of the Import Licensing Department.

When the I.L.D. receive the form they endeavour to find out—often by contact with trade associations—whether equivalent goods can be manufactured in Great Britain. If they are satisfied that there is a British "substitute" they will make contact with the British firm—or firms—concerned and ask if they are in a position to manufacture and deliver such goods within a reasonable space of time. The British firm will probably be glad of such a unique opportunity of removing foreign competition and will usually—unless overwhelmed with Government work—reply in the affirmative.

A few days after, a letter is sent to the intending importer to tell him that his application has been rejected and advising him to get into touch with certain British firms.

How Circumstances Alter Cases

The circumstances will not have been closely scrutinised by the Import Licensing Department, who cannot through the medium of the application form have heard much of the importer's case. Therefore it is expedient to dwell for a moment on the possible ramifications of a desired importation as circumstances may alter cases—or, in fact, may go so far as to persuade the I.L.D. that this is perhaps a case after all which calls for their further consideration. Upon the nature and the extent of this "further consideration" the issuing of the licence depends.

In the event of the goods being for urgent delivery and providing that they are of sufficient importance it is often found that the I.L.D. will issue the licence. It must be necessarily a case of there being no time for the goods to be manufactured in Great Britain—this usually means that the goods have actually reached British shores.

Price and Quality not Considered

I should like to mention here that the I.L.D. will not consider questions of price and quality of the goods—this I have been told during my negotiations with them.

Price is a controversial matter and is often associated with "dumping" of goods in this country; on the other hand, it may mean that productions abroad are better and under cheaper conditions for various reasons, &c.

Quality is a matter of more serious importance—especially in the case of machinery. Some machinery and parts have probably been imported for years purely on merits; also, the purchasers have probably made certain goods their "standard practice," and, in any case, surely the I.L.D. should make reference to them as well as to the British competitors: this is only fair!

General Considerations

So far nothing has been said from the point of view of the exporting country, but I will now endeavour to fill that omission.

When the first Prohibition Order was introduced in October last year it was the first intimation to our friends abroad that their goods on arrival at British shores would probably be rejected. It must be conceded that many goods already on their way here when the Order was introduced were allowed to come in; but surely this was nevertheless a very abrupt way of treating other countries. Would we have liked it if they had treated us in a like manner? To-day we are trying to build up our export business and know full well how we expect the markets abroad to be waiting for our goods, so to speak.

There should at least have been a period in which a limited amount of all imports could come into Britain—the brake applied was too drastic, even if justified.

A second consideration is that goods turned away from British shores might very well find their way to the enemy. Take a firm abroad with a limited output and let it be supposed that hitherto they have given preference to Britain. The result of the rejection of such goods may well be that they are sold to Germany instead—the very thing that the Minister of Economic Warfare is out to prevent.

Moreover, such goods, if they are vital machinery, may well serve to strengthen the enemy's war resources; vital marine engines or parts may go to make faster German submarines and warships, &c.

The Future

It has not been possible in this short article to cover the whole ground of the pros and cons of imports and import restrictions, but it would leave the article incomplete not to mention a last and rather important aspect.

The aspect I refer to is the future of the import trade. We shall not—we trust—always be at war, and so these war-time emergency regulations and modifications must necessarily one day come to an end. The point is that imports may flow into a country as through a "tap," but that once the tap is turned off it may be very difficult to cause the flow to recommence.

This possibility—or rather definite probability—must be considered in conjunction with the realisation that there is a definite link between imports and exports, and that if the one suffers the other must sooner or later suffer also.

Conclusion

This article may have read rather as a plea from the machinery importer himself; but it has been intended rather as a description and an illustration of the way in which the Orders have been introduced, have operated, and to criticise to the best of my experience and ability what I consider to be serious defects.

I can only add that it is to be hoped that with time and with experience to their credit the Government Departments concerned will see fit to modify the regulations considerably and to control rather than to kill importations into this country.

Civil Pilots Ferrying R.A.F. Aircraft.—The first all-civil ferry pilots pool, formed for the purpose of ferrying aircraft from contractors' works to their Royal Air Force destinations has been opened. Its personnel consists of forty pilots of the Air Transport Auxiliary who have spent four months with R.A.F. units to learn the work and gain experience in flying military aircraft.

Obituary

HARRY WAUCHOPE

THE Southern Railway Company has lost a devoted servant, and Southampton a distinguished engineer, by the death on Wednesday, February 14th, at his home, 78, Gordon Avenue, Southampton, of Mr. Harry Wauchope, who for many years has been the Chief Electrical Engineer of the Docks and Marine Department of the Southern Railway Company. Harry Wauchope, who was born abroad, received his early education at Kelvinside Academy, Glasgow, and served his apprenticeship with the North British Railway Company, completing his technical education at the Royal Technical College, Glasgow. On finishing his training he gained some civil engineering experience in the London office of his father-in-law, Mr. R. H. Brunton, M.I.C.E., and afterwards went to sea as one of the first sea-going electricians of the P. and O. Company. At a later date he joined the staff of the British Aluminium Company at Birmingham, and a few years after began his career with the London and South Western Railway Company, on the Waterloo and City Line, one of the first London tube railways.

In 1910, Mr. Wauchope was appointed Chief of the newly created electrical department of the London and South Western Railway, which was set up at the company's Southampton Docks. When he took charge the supply of electricity was produced by a small steam engine driven generating station. Under his guidance great advances in the uses of electricity in and around the docks took place. In 1924 a comprehensive scheme of electrification of all the pumping machinery was begun, and this along with the progressive installation of electric cranes, lifts, and other apparatus necessitated that the Southern Railway Company should take a bulk supply of current from the Southampton Corporation Electric Supply. From 1924, with the important extensions to the docks and warehouses, the use of electricity for power and lighting considerably increased. Among the more notable installations at Southampton with which Mr. Wauchope was closely connected were the large electrically operated floating dry dock, which was commissioned in 1924, and the pumping machinery and cranes for King George V Graving Dock at Southampton. Both of these important installations have been fully described in THE ENGINEER. Apart from his railway and dock duties, Mr. Wauchope found time to act as honorary consulting engineer to the Hants and Southampton Hospital. His death at the comparatively early age of 63 will be regretted by many friends.

JOHN CRAIG

THE marine engineering industry has lost a valued member in Mr. John Craig, who died on Friday, February 16th, at his home in Glasgow. He was born in Renfrewshire in 1874, and was educated at the Glasgow High School. Upon leaving school in 1890 he entered the works of G. and J. Weir, Ltd., as an apprentice. After completing his apprenticeship he served in turn in the drawing office and works office before assisting Mr. (later Sir John) Richmond in the estimating, sales, and contracts side of the business. In 1913 he was appointed to the board of directors upon which he served, in control of the estimating and contracts departments, until failing health compelled his retirement last year. He had an enviable reputation in the marine engineering industry, not only for his extensive knowledge, but for his attractive personality and fair-mindedness which, won him a wide circle of friends.

Literature

Aerodynamics. By Prof. L. BAIRSTOW. Second Edition. London: Longmans Green and Co., Ltd. Price 63s. net.

Aircraft Design. By C. H. LATIMER NEEDHAM. Vol. 2. *Aerostructures.* London: Chapman and Hall, Ltd. Price 16s. net.

Elements of Practical Aerodynamics. By Prof. BRADLEY JONES. Second Edition. London: Chapman and Hall, Ltd. Price 18s. 6d. net.

Aeroplanes and Aero Engines. By Captain P. S. SUMNER. Third Edition. London: The Technical Press. Price 15s. net.

THAT three out of the four of this very mixed bag should be re-issues is an indication, if such be needed, of the increasing interest taken by the technical reader in the subject of aviation; but the degree of education necessary to read each of them with profit ranges from a very high level in the first to the very simple conditions of the fourth.

Professor Bairstow's comprehensive and painstaking book is a second edition after the long passage of 20 years. The first edition was published just after the Four Years War, and the revised volume is ready in time for whatever there may be before the world now. After so long an interval it is natural that an enormous amount of rewriting and expansion have been required. It has evidently been done with great care and thoroughness.

The author shows a curious disposition to turn everything he can into mathematical formulæ. This is naturally regarded as a troublesome characteristic by the ordinary student of engineering, but in a treatise dealing with fundamentals, and written by a university professor mainly no doubt for the information of others who aspire to be as well informed as he is, it cannot be said to be entirely out of place. Nevertheless the author's style is sometimes strangely complex, even when a simple statement is possible; preference is nearly always given to a mathematical form. Thus, to give a simple example, in his brief reference to the operation of free spinning tunnels, he describes the requirements of the models thus: In order to ensure similarity of mass distribution, it is only necessary to have the . . . radii of gyration n times that of the aeroplane; the mass of the model should be n^3 the mass of the aeroplane. All that is meant by this is that the radii of gyration should be to scale, and the mean densities the same. This preference for mathematical language runs through the book, and makes it much more of an effort to read (if easier to write) than need be the case.

Aircraft have developed so marvellously during the 20 years interval between these two editions, that the engineering reader will be bound to seek in the new issue some indication of what scientific theory suggests the future may have in store. Instinctively he will turn to the chapter section dealing with aerofoil theory at supersonic speeds; he will find it brief and noncommital. But it does contain a pointer towards future very high speed aerofoil design; a very sharp nosed and exceedingly thin section probably being best, though with a lift to drag ratio but a half to one-third of the figures common with the conventional aerofoil of to-day. With increased air forces to provide for, and much less space inside the wing in which to put any strength members, it seems clear that the path of the aircraft constructor of to-morrow is not likely to be "roses all the way!"

The book is admirably illustrated; modern mathematical theories of air flow each receive attention, and are in most cases reproduced with a thoroughness for which research workers will be grateful. But it is no book for easy reading for any kind of student, and it comes as a relief to find the human touch that reproduces a remark, new to us and attributed to the late Lord Rayleigh, that the advancing wing makes use of the passing air on the "sacrificial principle" that "if you do not wish to fall yourself, you must make something else fall!" Professor Bairstow has built up his reputation as a professor at the Imperial College of Science and as Vice-Chairman of the Aeronautical Research Committee. This important volume epitomises his work and interests in both aspects of his life.

Mr. Needham's book is the sister volume to that reviewed some months ago in this journal. The earlier volume dealt with the aerodynamic aspect of aircraft design. It was in many ways an attractive book; the arguments were in readable form and easy to follow. The present volume is, however, very different. It may be described as a book written on the general subject of "Applied Mechanics" in which all the problems to be tackled are chosen from aeronautical examples. Hence it becomes a convenient handbook for drawing office use; a book which no one could be expected to read, but one which many might wish to consult. We should not recommend it to students, as it is far better than they should learn their first principles in a generalised form, which they can themselves apply to any field of practice in which their post-graduate experience may chance to lie.

The diagrams and illustrations are exceptionally good, and the author is to be complimented on the careful attention which he has evidently given to this part of his task. The general lay-out of the book, the way the chapters are divided up, the order in which they come, all these are reasonable and call for no comment, but if this second volume falls somewhat below the considerable promise of the first, nevertheless there will be many aircraft designers who will be glad to welcome it.

Professor Bradley Jones' book comes from the University of Cincinnati, U.S.A. In his preface to the earlier edition, the author expressed his conviction that a book intended primarily for the class-room should be different in character and scope from books intended for reference for practising engineers. There is truth in this, and no doubt much of the undoubted clarity in Professor Jones' book is due to having had the precept steadily in mind. On the other hand, the practising engineer will be surprised to find students being given examples (page 39) in which a "persuit aeroplane" is designed with a wing loading as low as 7·4 lb. per square foot. A lesser peculiarity is due to the word "prop," apparently meaning airscrew. Nevertheless this is a thoroughly readable book of fairly simple character which will certainly find its circle of student readers.

Of Captain Sumner's book it is difficult to know what to say. It is indeed hard to see for whom it is written. But, as it has reached a third edition, it must have aimed with moderate success at some market. It is semi-technical, yet not "popular," and the illustrations are frequently of an astonishingly poor quality. The book claims, in its preface, to have been "brought thoroughly up to date," but the description of the Turn Indicator (page 224) relates to a model (pressure gauge type) which was entirely obsolete 20 years ago, and of which we suspect there is not a single sample fitted in any airplane now flying in any part of the world. Nor does the author refer at all to the gyroscopic model now universal. Readers of any knowledge will have their confidence severely shaken by being given such information.

Jigs, Tools, and Fixtures. Second edition. By Philip Gates. London: The Technical Press, Ltd., 5, Ave Maria Lane, E.C.4. Price 10s. net.

WHEN a shop is being laid down for the manufacture of interchangeable parts it is of the utmost importance that the jigs and tools to be used in the various operations shall be of the most suitable design to ensure economic and rapid production. Although jigs and tools naturally vary to a considerable extent, according to the work being carried out, they all have certain features in common and it is with these features that this book is principally concerned. It opens with brief, practical, chapters on the drawing, sketching, and design of jigs, tools, and fixtures, and the following sections deal in some detail with drill jigs, milling fixtures, cutters, screwing equipment, gauges, press tools, &c. A useful chapter is given on the procedure which can be adopted in a jig and tool office and this is supplemented by information on standardisation. The book concludes with sections on the magnetic and pneumatic gripping of parts and a short dissertation on materials. Each chapter is illustrated and includes drawings of typical tools, and a number of useful tables are given. Although experienced designers will find much of the information given in this book quite familiar, it will prove a useful guide to all students and others interested in the design of jigs and fixtures for mass production, particularly in connection with motor vehicles.

BOOKS RECEIVED

Engineering Physical Metallurgy. By R. H. Heyer. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 25s. net.

The Blue Book: The Electrical Trades Directory and Handbook, 1940. London: Benn Brothers, Ltd., 154, Fleet Street, E.C.4. Price 25s. net.

Laboratory Studies of Asphaltic Cements. By F. C. Lang and T. W. Thomas. Minneapolis: Engineering Experiment Station, University of Minnesota, U.S.A.

Civil Defence. Second Edition. By C. W. Glover, M.I.C.E. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 36s. net.

Soldering and Brazing, and the Jointing of Metals. By T. Bolas, F.C.S. London: Percival Marshall and Co., Ltd., 60, Kingsway, W.C.2. Price 1s. 6d. net.

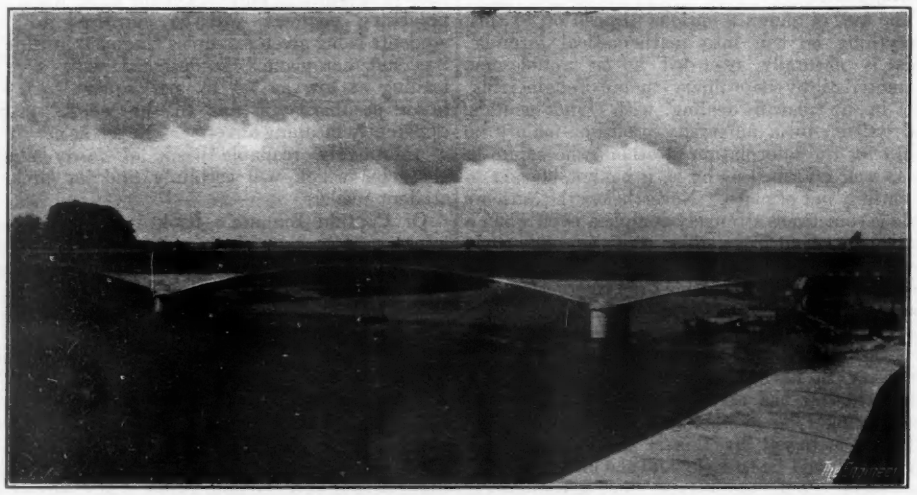
The Lost Republic: The Biography of a Land Surveyor. By Gustav Bauman and Elfrieda Bright. London: Faber and Faber, Ltd., 24, Russell Square, W.C.1. Price 12s. 6d. net.

Studies in Reinforced Concrete: Further Investigations on the Creep or Flow of Concrete under Load. By W. H. Glanville, D.Sc., and F. G. Thomas, Ph.D. London: His Majesty's Stationery Office, York House, Kingsway, W.C.2. Price 1s. net.

Villeneuve-St. Georges Bridge, France

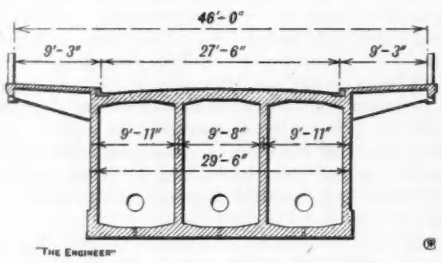
THE new bridge over the Seine at Villeneuve-St.-Georges carries a 27ft. 6in. roadway and two 9ft. 3in. footways across the river. On the left bank there are eleven 34ft. 6in. spans carrying the approaches. The river piers are in mass concrete resting on a heavy reinforced concrete raft, 3ft. 3in. thick founded on 53 Rodio pressure piles.

A monolithic ribbed structure, 448ft. long covers the centre span and projects 96ft. 6in. towards the bank on either side of the river piers. Two independent ribbed slabs join the ends of the cantilever slab to the abutments. The deck is carried on the left bank pier by means of a concrete hinge and on the right bank pier by means of a pendulum bearing.



VILLENEUVE-ST. GEORGES BRIDGE OVER THE SEINE

The footways are cantilevered over the side ribs to a distance of 8ft. 3in. The deck forms the top member of a hollow ribbed structure with four ribs and a lower curved slab. The deck varies in thickness from 7in. to 14·7in., and the ribs from 7in. to 17·8in.,



SECTION THROUGH BRIDGE

depending on the load. The 4 ribs are spaced at 9ft. 11in., 9ft. 8in., and 9ft. 11in. centres. There are also transverse diaphragms, 6·4in. thick at 16ft. centres. In view of the importance of avoiding deleterious effects resulting from variations in the temperature and humidity of the air within and without a closed concrete structure, special attention has been paid to the ventilation of the hollow ribs.

It may be remarked that the more usual method would have been to put the hinges in the centre span, but the fact that an existing wall of doubtful strength had to be used for the right bank abutment rendered it desirable to limit the reaction. The joints were therefore placed in the side spans. The main structure is hinged on the left bank pier. On the right bank pier the bridge is carried by means of a pendulum bearing 6ft. 3in. high by 1ft. 8in. thick. The hinge and the pendulum are designed to take a maximum load of 2600 tons each. The hinges in the side span are of the same type.

The bridge is designed to take a uniformly distributed load of 83 lb. per square foot on the footways, and 105 lb. per square foot on the roadway. Alternatively, the deck is designed to take a standard load made up of 3 groups, each of two 16-ton lorries. A wind pressure of 52 lb per square foot was assumed on the unloaded structure.

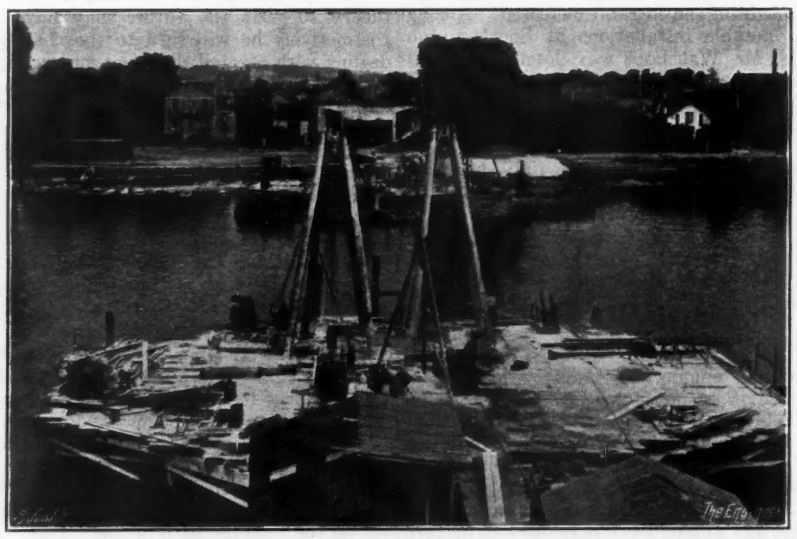
The concrete was made with 590 lb. of high strength cement per cubic yard, and the specified 90-day strength of 4560 lb. per square inch was exceeded. Working stresses of 1280 lb. per square inch in compression, and 128 lb. per square inch in shear and adhesion were adopted. The reinforcement was in semi-hard steel, giving an elastic limit of 23 tons and a breaking strength of 34 tons per square inch with an elongation of 15 per cent. According to the French regulations, the maximum allowable working stress was 11½ tons per square inch, but for extra safety a value of 10·2 tons per square inch was adopted.

The left bank pier was constructed first, and then the right bank pier. The centering consisted of three distinct parts :—

Two centres for the side spans and the end portions of the central span. These centres were supported on timber piles 16ft. apart.

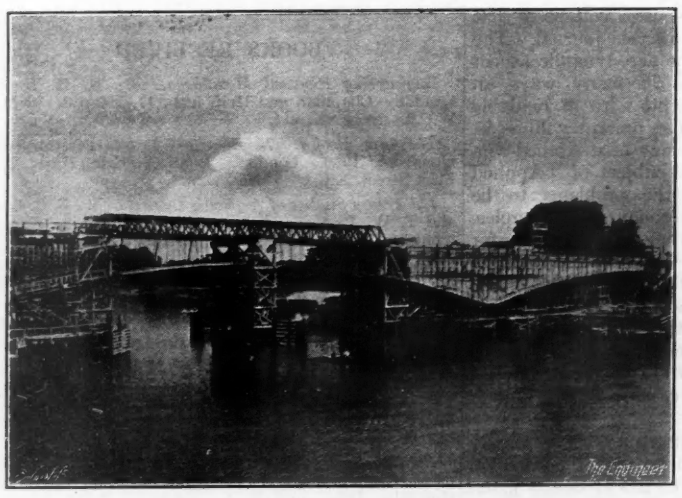
The centres for the mid portion of the main span, which were suspended from a latticed steel girder, 164ft. span.

To comply with the requirements of the Navigation Board, two passages, each 59ft. wide and 9ft. 8in. clear above the highest water level had to be kept open for navigation. For this reason, the lattice steel girders, carrying the centering of the mid portion were supported on a centre pier of 24 timber piles and two end piers each of 18 piles. The bridge was built in three stages. The left side span was first concreted, then concrete was poured into the forms of the right side span, and finally the mid portion of the central span was erected. The bridge was subjected to two test loads before being opened to traffic. During the first test stationary loads (sand, 80 lb. per square foot for the footways) and movable loads (six lorries weighing 16 tons each) were placed to produce the maximum stresses at various sections. The second test consisted of loading the whole structure with a stationary load (sand, 80 lb. per square foot for the roadway and the footways). The results of the loading demonstrated that the bridge structure had great rigidity. The total cost of the structure (including the approaches) was 6 million francs.



EARLY STAGE IN ERECTION OF BRIDGE

The quantities of materials used on the contract were 2170 cubic yards of concrete and 490 tons of steel. The bridge has been built to the design of



SUSPENDED MIDDLE PORTION OF CENTERING

COMPLETED CENTERING

M. Henry Lossier, consulting engineer, by the Etablissements Fourré and Rhodes, of Paris. The work was done under the direction of M. Arnaud, chief engineer of the Highway Boards. A number of engravings illustrate the progress of the work and a cross-sectional drawing is reproduced.

Area Advisory Committees

THE Ministry of Supply announces that the Area Advisory Committees at Bristol, Nottingham, Leicester, and Lincoln have been inaugurated and will shortly hold their first meetings. The members of the Committees are as follows:—

Bristol.

Nominated by Engineering Employers Federation: Mr. F. McKenna (Gloster Aircraft Company, Ltd., Gloucester); Mr. F. Lister (R. A. Lister and Co., Ltd., Dursley); Mr. H. V. Slade (Garrard Engineering and Manufacturing Company, Ltd., Swindon); Mr. A. Willis (Brecknell, Willis and Co., Ltd., Bristol); Mr. A. G. Strong (H. O. Strong and Sons, Ltd., Bristol); Mr. A. W. Grant (Chairman, Engineering and Allied Employers, West of England Association); Colonel Pitt (Stothert and Pitt, Ltd., Bath); Mr. J. G. Young (Climax Rock Drill and Engineering Works, Ltd., Carn Brea); Mr. G. Tyler (the Bickle Engineering Company, Ltd., Plymouth).

Nominated by Trades Union Congress: Mr. E. R. V. Porter, Mr. H. M. Medland, Mr. C. Parsons, Mr. J. T. Machin (Amalgamated Engineering Union); Mr. H. Tutt (National Union of Vehicle Builders); Mr. F. Stanford (National Society of Brass and Metal Mechanics); Mr. F. Ashley (National Union of Sheet Metal Workers and Braziers); Mr. J. Flowers (Transport and General Workers Union); Mr. H. C. Pullin (National Union of Foundry Workers).

Nottingham.

Nominated by Engineering Employers Federation: Mr. Robert Sims (Manlove Alliott and Co., Ltd., Nottingham); Mr. J. H. Bingham (Metropolitan Gas Meters, Ltd., Nottingham); Mr. F. H. Starling (Blackburn Starling and Co., Ltd., Nottingham); Mr. F. V. Piper (Newton Bros. (Derby), Ltd., Derby); Mr. J. P. Gilliver (International Combustion, Ltd., Derby); Mr. R. Matthews (Secretary, Engineering and Allied Employers' National Federation, Derby and District Association); Mr. W. B. Briggs (S. Briggs and Co., Ltd., Burton-on-Trent); Mr. G. Robinson (Sanderson and Robinson, Ltd., Mansfield); Mr. W. C. Macartney (Markham and Co., Ltd., Chesterfield); Lieut.-Colonel S. M. Tate (Chesterfield Tube Company, Ltd., Chesterfield).

Nominated by Trades Union Congress: Mr. C. R. Bates, Mr. W. H. Gilkes, Mr. A. Sturgess, Mr. H. Parsons (Amalgamated Engineering Union); Mr. H. Hodgkins (Boilermakers and Iron and Steel Shipbuilders Society); Mr. S. C. Richardson (Electrical Trades Union); Mr. R. A. White (National Amalgamated Furnishing Trades Association); Mr. M. Lowe (National Union of General and Municipal Workers); Mr. F. Moss (National Union of Foundry Workers); Mr. R. R. Ponton (Association of Engineering and Shipbuilding Draughtsmen).

Leicester.

Nominated by Engineering Employers Federation: Mr. H. S. Pochin (Goodwin Barsby and Co., Ltd., Leicester); Mr. J. H. Goddard (Wadkin, Ltd., Leicester); Mr. R. G. Hosking (S. Russell and Sons, Ltd., Leicester); Mr. J. R. Gimson (Gimson and Co. (Leicester), Ltd); Mr. H. H. Moore (Herbert Morris, Ltd., Loughborough); Mr. L. G. Reid (Brush Electrical Engineering Company, Ltd., Loughborough); Mr. C. Pratt (Blackstone and Co., Ltd., Stamford); Mr. V. Amberg (Express Lift Company, Ltd., Northampton); Mr. J. M. Lowry (Secretary, Engineering and Allied Employers, Leicester and District Association); Mr. A. M. Neal (Peter Brotherhood, Ltd.).

Nominated by Trades Union Congress: Mr. E. J. Taylor, Mr. G. H. Dean, Mr. H. Done, Mr. C. Sendall (Amalgamated Engineering Union); Mr. C. A. Whitehead (Amalgamated Society of Woodcutting Machinists); Mr. W. H. Hill (National Union of Vehicle Builders); Mr. S. C. Richardson (Electrical Trades Union); Mr. R. A. White (National Amalgamated Furnishing Trades Association); Mr. A. E. Jakins (National Union of Foundry Workers); Mr. G. Davidson (Association of Engineering and Shipbuilding Draughtsmen).

Lincoln.

Nominated by Engineering Employers Federation: Mr. W. T. Bell (Robey and Co., Ltd., Lincoln); Mr. A. R. Bellamy (Ruston and Hornsby, Ltd., Grantham); Mr. V. W. Bone (Ruston-Bucyrus, Ltd., Lincoln); Mr. M. Burton (Marshall, Sons and Co. (Successors), Ltd., Gainsborough); Mr. F. Caddick (W. J. Jenkins and Co., Ltd., Retford); Mr. J. A. Doig (J. S. Doig (Grimsby), Ltd., Grimsby Docks); Mr. J. T. Graham (Worthington-Simpson, Ltd., Newark-on-Trent); Mr. C. G. H. Richardson (Ransome and Marles Bearing Company, Ltd., Newark-on-Trent); Sir W. A. Tritton (William Foster and Co., Ltd., Lincoln); Mr. J. W. F. Hill (Engineering and Allied Employers, Lincoln, Gainsborough and Newark Association).

Nominated by Trades Union Congress: Mr. J. J. Leamy, Mr. J. W. Jessop, Mr. G. W. Bowen, Mr. P. W. Graville (Amalgamated Engineering Union); Mr. R. T. Sharpe (Boilermakers and Iron and Steel Shipbuilders Society); Mr. G. Deer (Transport and General Workers Union); Mr. J. L. Fox (National Union of Vehicle Builders); Mr. F. Wallis (Amalgamated Society of Woodworkers); Mr. E. W. A. Day (National Union of Foundry Workers).

The Chemical Plant Manufacturer and Chemical Industry

AT a meeting of the Chemical Engineering Group of the Society of Chemical Industry, held in London on Friday, February 16th, a discussion was held on a paper which was prepared before the war and was published in *Chemistry and Industry* dated December 30th, 1939, on the subject of the chemical plant manufacturer in relation to chemical industry. Its authors were Mr. Brian N. Reavell and Dr. G. E. Foxwell. In it they discussed the functions of plant manufacturers, plant users and consultants, and made an arbitrary classification of British chemical plant manufacturers into three groups: (1) firms manufacturing plants to their clients' general designs, and which might own quite large works in which the manufacture of chemical plant was only one of their activities; (2) firms specialising in the design and manufacture of chemical plant specialities or units, *e.g.*, acid pumps, filters, centrifuges, &c.; and (3) firms providing complete process plants, able to piece together a series of unit plants to work in harmony, and who would undertake responsibility for the entire process and would make suitable guarantees to the purchaser.

The authors summed up their impressions of the present scope of the British chemical plant industry in relation to the chemical industry by stating that a chemical manufacturer or consultant requiring a plant manufactured to his own designs, drawings, and specification would have no difficulty in obtaining it from British firms, generally in Group 1; that for a special unit, for which he had not detailed drawings and specifications, he should go to a Group 2 manufacturer; and for a complete process he should discuss his exact requirements with a Group 3 firm. If the process were unknown or seldom required, he should call in a consultant and obtain a specification for the process and, if possible, for the various plant units necessary to operate it. Failing that, co-operative experimental work would generally lead to a satisfactory solution.

A good deal of attention was directed, in the course of the discussion, to the superiority, or alleged superiority, of foreign, particularly German, firms in the matter of quoting for complete process plants. It was suggested by some speakers that it was more apparent than real and, in the words of Mr. W. Edmund Evans, was due chiefly to their sales organisations and their policy to "have a stab" at a thing whether they could handle it or not.

An interesting light was thrown on this matter by Mr. Reavell when he mentioned a conversation he had had, since the paper was written, with a gentleman who had been a director of a German chemical engineering firm, and who, owing to the political situation, had had to leave Germany. He had said that at one of the last directors' meetings of the firm, which he had attended, it had been decided that the cost of preparing quotations for complete process plants in all parts of the world had proved to be prohibitive, and that in future the firm would quote only for process plants of which it had direct experience.

There was much comment by speakers on the difficulties of chemical plant manufacturers who were asked for quotations by chemists from various parts of the world who really wanted to obtain information which they should have known already, and who were not likely to order plant at all. Mr. Hugh Griffiths made a pungent criticism when he referred to cases in which a chemical manufacturer, who ought to know his business, but did not, asked for a quotation from a chemical plant manufacturer who could not hope to know the business nearly so well as the chemical manufacturer should do; and the latter foolishly assumed that if the plant manufacturer did know more than he did about the manufacture, the plant manufacturer would put it on paper for nothing and submit it as a quotation. Then the chemical manufacturer could study the quotation, draw up specifications, and send them round to his local ironmonger and have the plant built! That sort of thing, he said, had occurred on more occasions than those on which the orders had been given to the chemical plant manufacturer.

The plant manufacturer, of course, was criticised equally with the plant users, and references were made to the system in Germany whereby enquiries for plant were handed from one firm to another until they reached the firms most competent to deal with them. The need for more development work by plant manufacturers was stressed by some speakers, and they were told they must not rely too much upon the chemical industry telling them all about its discoveries and asking for plants to make the newly-discovered products. Obviously, in the long run, the plant users would have to pay for the development work. A suggestion by Mr. Evans was that if there were an organisation with headquarters having the knowledge to link together unit processes to make an efficient plant, and having available a panel of specialist consultants to advise on enquiries, the enquiries could be dealt with by the plant manufacturing industry without any fundamental alteration of its present structure, and the cost of the necessary staff of experts for development work could be spread over a large section of the industry, so that the plants produced would not be hopelessly overloaded with costs.

Sixty Years Ago

GAS ENGINES

IT was evident, we wrote in our issue of February 20th, 1880, that the prejudice which originally existed against the gas engine was being rapidly overcome. That prejudice, we said, had its origin in the failures of the early engines before the combustion and combination of gases had been thoroughly investigated. It had also been greatly increased by the jealousy shown by the makers of small steam engines who had seen in the gas engine a formidable rival to their own productions, and had naturally decried it. Proceeding, we gave brief descriptions of the principal gas engines then on the market. Delving into the history of the subject we mentioned Barber's patent of 1791, Mead's of 1794, Street's also of 1794, and Wright's of 1833. In 1860, J. Lenoir and P. Hugon patented gas engines which seem to have had much in common. The real development of the engine began in 1863 with the Otto and Langen patent—improved in 1866. The manufacture of the "Otto" engine in this country was taken up by Crossley Brothers of Manchester, and up to the time of writing over four thousand "Otto" engines with their rack and ratchet wheel connection between the piston and the flywheel shaft had been made here and on the Continent. They were stated to be "extremely economical in practice," consuming only 21 cubic feet of gas per indicated horse-power hour. A rival to the early "Otto" engine was patented by Gilles of Cologne, in 1874, but two years later the "silent" gas engine was produced by Otto and Langen and set developments along new lines. This engine introduced the gradual expansion of the gas and air charge, on the now familiar "Otto" cycle. Our article also mentioned the engines patented by Louis Simon and Son, of Nottingham, in 1877, by Clayton and Co., of Bradford, in 1878, and by Hellewell, of Blackburn, in the same year, and an engine patented by Bischop of Paris and made in this country by J. Andrews of Stockport. Finally we mentioned Mr. Dugald Clerk's engine made by Thompson, Sterne and Co., of Glasgow. In this horizontal single acting engine air and gas were compressed in a pump. On admission to the working cylinder the charge was ignited by means of a small piece of platinum wire which once having become heated remained sufficiently hot to initiate combustion. The makers claimed that the consumption of the Clerk engine was only 15 cubic feet of gas per indicated horse-power hour. In a succeeding issue, Mr. Robert Wilson threw doubt on the alleged economy of the Clerk engine, and asked that it should be substantiated by independent and competent witnesses. Another correspondent saw no reason why the consumption of either the Clerk or the silent "Otto" engine should not be less than 15 cubic feet per I.H.P. hour, but suggested that it would be more to the point if the respective makers would give the consumption per *brake* horse power hour.

SCHOLARSHIPS IN ELECTRICAL ENGINEERING.—Applications, which must be received not later than April 15th, 1940, are invited for the following Scholarships awarded by the Council of the Institution of Electrical Engineers. Duddell Scholarship. (Value £150 per annum, tenable for 3 years). Ferranti Scholarship. (Value £250 per annum, tenable for 2 years). Swan Memorial Scholarship. (Value £120, for one year). Silvanus Thompson Scholarship. (Value £100 per annum and tuition fees, tenable for two years). William Beedie Esson Scholarship. (Value £120 per annum, tenable for two years, renewable in approved cases for a third year).

ACCIDENT PREVENTION.—The Midland Electric Manufacturing Company, of Birmingham, has to its credit an accident record for last year which is an example of what can be done by sound precept coupled with constant vigilance. Although the average number of employees increased by 15 per cent. and the man-hours worked by 25 per cent. during the year, the total number of lost time accidents was reduced from 18 to 15. The number of hours lost showed the remarkable decline of over 50 per cent. About 1000 people are employed. A full-time Safety Officer is employed, and the company maintains a fully equipped surgery with a trained nurse in attendance. Regular "Safety Bulletins" are produced bearing reference to some topical event. A "Safety Museum" in the form of a show case, one side depicting some gruesome accident, with a connecting ribbon to the other side showing the means of prevention, is exhibited in the works. Great interest is taken in first aid work, and over 60 employees hold certificates, vouchers, or medallions issued by the St. John Ambulance Association.

Nut Tightness

By H. L. DAWTREY*

IN a previous paper the author made brief reference to stresses in bolts due to nut tightness.† In these days when tension wrenches are coming into more general use, there arises the possibility of controlling the tightness and also the stress in the parts.

It is no uncommon experience to find the smaller diameter bolts stretched, even though made from fairly high tensile material.

The following formula has been developed:—

$$T = W\,[r_s \tan(\alpha + n\varphi) + r_t \tan\varphi] \quad . \quad . \quad (1)$$

Where T is the torque applied to the nut, lb. in.
α is the helix angle of the thread.
φ is the friction angle ($\tan\varphi = \mu$).
n is the ratio $\dfrac{1}{\cos\beta}$, where β is half the included angle of the thread form ($27\frac{1}{2}$ deg.).
r_s is the mean radius of screw thread, in.
r_t is the mean radius of the nut thrust face, in.
W is the tensile load in the bolt, lb.

The tightness of a nut evidently depends, apart from its dimensions, on the torque applied and the coefficient of friction resisting the tightening process. Within the friction range met with, the law is of straight line form.

The friction radius of the nut is given by

$$r_t = 0{\cdot}2625\,D + \frac{d}{4} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Typical values are given in Table I.

Test results show good agreement with the theory that for any given combination of nut and bolt, stressed within the elastic limit, the relation between torque T and load W is a straight line.

For instance, one particular $\frac{1}{2}$in. B.S.F. bolt gave a straight line up to 60ft.lb. torque and 4200 lb. load, as shown in Fig. 1 by the black dots. The torque is applied through two spring balances at an arm of 2ft. diameter, and the resulting tightness is measured by blocking the beam of the testing machine during tightening, then the block is removed and the load produced during the tightening process is measured in the usual way.

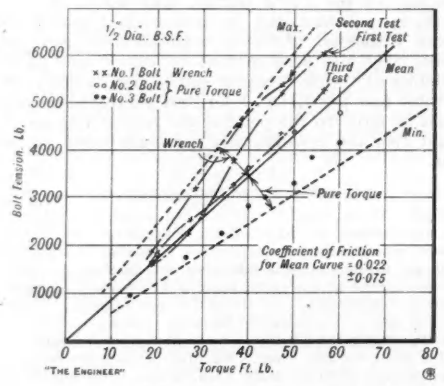


Fig. 1—*Tests on ½in. Bolts*

Fig. 2 shows the "U" pieces used to convert bolt tension into measurable thrust. In the case of this ½in. bolt, the coefficient of friction, using formula (1), is seen to be 0·265. This is sliding friction, the torque being applied at a steady speed. However, the mean of numerous tests is more nearly 0·22, as shown in Figs. 1 and 3, which give results for ⅝in. and ½in. diameter B.S.F. threads. The spread of results about the mean line is rather wide, corresponding to a variation in friction of ±0·035 for the ⅝in. diameter tests, and ±0·075 for the ½in. diameter tests. It will be seen in Fig. 1 the same nut, when retightened, gives different results, being very near the mean at the third tightening.

These tests refer to commercial nuts and bolts.

For the purpose of the following comparisons and comments, a value of 0·22 is used for the coefficient of friction, and is assumed the same for both the screw threads and the nut face.

Fig. 4 shows variations of bolt tension with spanner torque, and spanner torque for given tension with various friction values.

These figures show the tendency for small bolts to be overstressed; they also tend to be tighter for a constant spanner length.

It is usual to use the next size smaller Whitworth hexagon for the nuts of B.S.F. bolts. The spanner lengths (double open end) are about as follows:—

¼ and 5/16in. B.S.F.	4in.
⅜ and 7/16in. B.S.F.	5½in.
½in. B.S.F.	7in.

For equal hand load applied to tighten we have the following ratios, where a high value indicates high bolt tightness or stress:—

B.S.F. diameter in.	Tightness ratio	Stress ratio
¼	1·00	1·00
5/16	0·91	0·57
⅜	0·97	0·40
7/16	0·82	0·25
½	0·91	0·21

It will be seen that these spanners give substantially equal tightness, but unequal stress. But we would require a higher load for larger bolts corresponding to equal stress.

Some tightening tests on a ⅜in. diameter B.S.F. bolt and nut, in which the bolt had a tensile stress of 61 tons per square inch and the nut 43 tons per square inch resulted as follows:—

For the case of a normal open-ended spanner, the nut only normally tight, a tensile load of 2350 lb. was obtained. Continued tightening showed a definite yield at 75ft.-lb., and tensile load of 8800 lb. From Fig. 4 of torque-μ curves we find $\mu = 0{\cdot}21$ for this case.

The tensile stress at the root of the threads for a load of 8800 lb. is 51·7 tons per square inch. There is also a shear stress due to the tightening torque of 32·5 tons per square inch, resulting from thread friction and mechanical effort. The resultant stress is 67 tons per square inch, neglecting stress concentration at the root of the threads. This exceeds the tensile strength of the material, but such examples of apparent strength, higher than tensile strength, are common. For instance, a spring blade treated to tensile strength of 90 tons per square inch will probably remain unbroken under a bending load corresponding to a stress of 120 tons per square inch, due to having passed the yield point in the skin of the blade and so having a modulus of resistance higher than would be calculated by theory based on elastic laws.

It is probable that a bolt at the point of failure has passed the yield point almost to its centre, with respect to the torque component, as well as being stressed past the yield point for tensile load.

For simplicity it will probably be sufficient to calculate only for tensile loads, and it may be noted that they form the largest factor, as shown by the "necking" and reduction of area occurring, similar to the case of a tensile test piece. Thus we assume the breaking point is reached when a tensile stress equal to the material strength has been attained. On this basis Tables II and III are prepared.

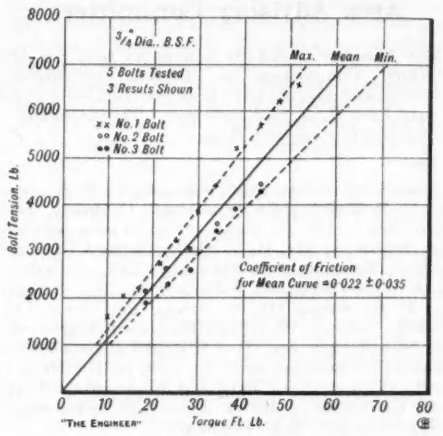


Fig. 3—*Tests by Calibrated Wrench and by Pure Torque, Within the Maximum and Minimum Limits Shown.*

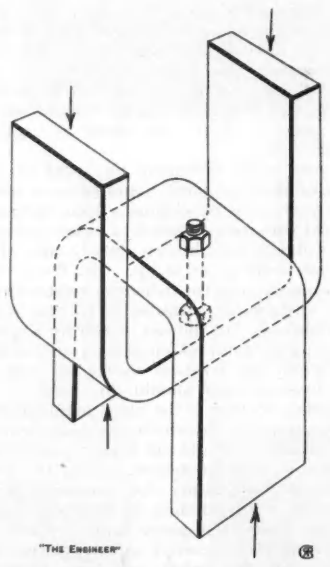


Fig. 2—*"U" Pieces for Nut Tightness Tests*

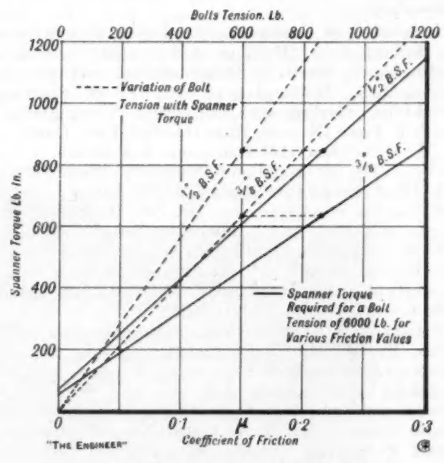

Bolts Tension. Lb.
Variation of Bolt Tension with Spanner Torque
1/2 B.S.F.
3/8 B.S.F.
5/16 B.S.F.
Spanner Torque Required for a Bolt Tension of 6000 Lb. for Various Friction Values
Spanner Torque Lb. In.
Coefficient of Friction
"THE ENGINEER"

Fig. 4—*Bolt Tension Curves (Calculated)*

TABLE I—*Showing Variation of Bolt Tightness and Core Stress for Equal Torque*

B.S.F., diameter inch and threads per inch.	Nut hexagon flats, in.	Area of root of threads, square inch.	r_s	r_t	α deg.	ϕ deg.	Assumed torque applied to nut, lb. in.	Tensile load, lb.	Corresponding tensile stress, tons per square inch
¼ 26	0·445	0·0316	0·113	0·180	3·17	12·4	250	3360	47·5
5/16 22	0·525	0·0508	0·142	0·216	2·93	12·4	250	3055	26·9
⅜ 20	0·600	0·0760	0·172	0·251	2·65	12·4	250	2345	13·8
7/16 18	0·710	0·1054	0·201	0·295	2·52	12·4	250	2010	8·5
½ 16	0·820	0·1385	0·230	0·340	2·47	12·4	250	1752	5·65

TABLE II—*Results of Tightness Tests.*

Diameter B.S.F. in.	Tightness, lb.	Direct tensile stress, tons per square inch	Factor of safety for material of tensile strength, in tons per square inch of		
			35	55	75
		Normal tightness. Approx.			
¼	2460	34·7	1·0	1·58	2·16
5/16	4700	27·7	1·26	1·99	2·71
⅜	5790	18·4	1·90	2·99	4·08
		Very tight.			
¼	Three bolts broke at root of threads	—	None	None	—
⅜	Nut threads sheared at third tightening 9240	54·4	None	Approx. 1·00	1·38
½	8250	26·6	1·32	2·06	2·82

It is interesting to note how the total nut tightening torque is made up for a ⅜in. diameter bolt, B.S.F. thread.

Mechanical leverage of the screw	1 part
Thread friction	5½ parts
Nut face friction	7 parts
Total	13½ parts

The efficiency of the screw is thus 7½ per cent. approximately.

A table showing the results of tightening tests is given above, in which normal and very tight conditions using open-ended spanners were obtained.

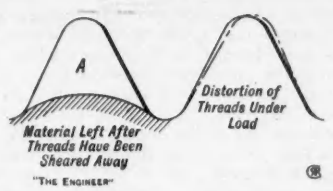
* Institution of Automobile Engineers, from a paper entitled "Some Problems We Meet." *Journal*, February, 1940.

† "Some Problems in Chassis Design," Proceedings for 1933–34.

Factors of safety for various material strengths are given. It will be seen that in one case the nut material was not strong enough for the bolt.

Usually it is found that a good mild steel nut of normal proportions is sufficient to break by tightening a medium tensile bolt of 50 to 60 tons per square inch, but for 70 to 80 tons per square inch bolts, 50 to 60 tons per square inch nuts are desirable.

By an approach of this character it is not difficult



Although root of sheared thread is as shown shaded, yet weight of material removed is less than that corresponding to area "A."

Fig. 5—*Thread Sections*

to specify suitable torque data for nut tightening, according to bolt material, or, alternatively, to choose the material or bolt diameter suitable for the tightness required.

For instance, if we choose a value for the factor of

TABLE III—*Suggested Torque Specification for Factor of Safety of Approximately 2 and $\mu = 0{\cdot}22$*

Diameter B.S.F., in.	35 tons per square inch material		55 tons per square inch material.		75 tons per square inch material	
	Torque, ft.-lb.	Tightness, lb.	Torque, ft.-lb.	Tightness, lb.	Torque, ft.-lb.	Tightness, lb.
¼	8	1290	12	1940	23	3720
5/16	14	2060	21	3090	29	4260
⅜	26	2930	41	4620	56	6300
7/16	43	4140	67	6450	92*	8850
½	65	5450	100*	8400	138*	11,600

* NOTE.—These high-torque figures would probably not be used, a higher factor of safety being preferred.

safety of 2, we should specify torque figures as shown in Table III based on $\mu = 0{\cdot}22$.

STRENGTH OF NUTS (WITH REFERENCE TO THREAD SHEAR)

A table of test results is given below for the case of ⅜in. diameter B.S.F. threads. There are not sufficient results to allow us to formulate exact ideas, but some general notes can be made.

For instance, proportioning the values from columns *a*, c, and *e* to the equivalent of 55 tons per square inch material, we find :—

EQUIVALENT BREAKING LOAD FOR FIVE THREADS

(*a*) Nut threads	12,500 lb.
(*c*) Nut threads	11,350 lb.
(*d*) Bolt threads	10,450 lb.
Average	11,433 lb.

Some results other than those given in Table IV showed one sheared thread to weigh 0·057 gram.

TABLE IV—*Tests on ⅜in. B.S.F. Threads*

	Nut, tons per square inch	Number of threads	Yield load, lb.	Thread shear load, lb.	Bolt, tons per square inch	Sheared thread weight per thread
a	46	6·45	10,300	Limit of machine 11,550	80	Unbroken
b	46	5·0	—	11,420	80	Nut thread, 0·086 grm.
c	31	5·0	4700	7050	80	Nut thread, 0·048 grm.
d	80	5·0	6050	Bolt broke at root of threads	40	—
e	80	3·66	5600	6270	41	Bolt thread, 0·073 grm.

Columns *a*, *b*, and *c* refer to nut thread tests, and columns *d* and *e* to bolt thread tests.

The variation seems to depend on the ductility of the steel being tested.

Considering the differences in material and condition, the deviation between these shear load results is not marked. It thus appears that the ultimate tightening shear strength of the thread is 2290 lb., or approximately 1 ton per thread for 45 tons per square inch material, other materials and thread sizes being proportionate. Such data as this help when specifying material for nuts for high-tensile bolts, and indicate also that when the nut is of the same material as the bolt, 3½ threads are as strong as the root section for ⅜in. B.S.F.

However, 88 per cent. extra threads are allowed in practice (5/16in. thick nut), to allow for the effects of wear in the threads. If a 100 tons per square inch bolt is used, the 88 per cent. extra thread will not suffice to cover the additional strength required. Thus the nut material strength would be increased. It is already 88 per cent. more than 45 tons per square inch, *i.e.* equal to an 85 tons per square inch bolt. Thus we may increase the nut material strength to the following, allowing 25 per cent. extra thread strength :—

$$1{\cdot}25 \times \frac{100}{58} \times 45 = 66 \text{ tons per sq. inch or thereabouts.}$$

At the limit, the threads become distorted, as shown in Fig. 5, the nuts expand, and the thread sheared off is not of full depth.

The Unwin Memorial Committee

THE Unwin Memorial Committee was constituted in February, 1935, at a meeting held at the Institution of Civil Engineers, at which were represented the leading technical institutions, the colleges with which he had been connected, former students, and others interested in commemorating the life and work of the late Dr. W. C. Unwin, F.R.S.

It was decided that the principal objects to be aimed at were the raising of a sum sufficient to enhance to a more useful scale the value of a small existing Unwin Scholarship at the City and Guilds College, and the publication of a memoir, based on the special number of *The Central* issued after Dr. Unwin's death. An Executive Committee was appointed, under the chairmanship of Sir Alfred Chatterton, C.I.E., who was also chairman of the main Memorial Committee. With the assistance of the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, and Naval Architects, copies of an appeal were circulated to the members of these Institutions, and the Executive Committee took various other steps to raise the required fund.

In February, 1938, this committee was able to report to the Memorial Committee that the objects aimed at had been achieved. The latter, thereupon, at a meeting held in the same month, decided that the fund should be made over in due course to the City and Guilds of London Institute to be held in trust by that body to endow a scholarship at the City and Guilds College for a third year student of that college desirous of continuing his studies for a fourth year.

The committee wish to record their grateful thanks to past students of Dr. Unwin, and all others who have made this undertaking such a success. The amount originally asked for was £2500, and the gross amount received to date is £2949 12s. 8d., of which £2703 16s. 9d. was in the form of direct subscriptions. Special thanks are given to those who generously subscribed large sums in recognition of Dr. Unwin's valuable contributions to engineering practice. It is felt that the cordial expressions of support which accompanied these gifts afford ample justification of the task which the Memorial Committee set itself. Sums of £100 and over were received from :—Balfour, Beattie and Co., Ltd.; British Aluminium Company, Ltd.; British Allied Manufacturers Association, Inc.; British Oxygen Company, Ltd.; Cement Marketing Company, Ltd.; Thos. Firth and John Brown, Ltd.; Gas Light and Coke Company ; The late Sir J. Purser Griffith ; Sir Robert A. Hadfield ; the Rt. Hon. Viscount Nuffield ; Ruston and Hornsby, Ltd.; Vickers-Armstrong, Ltd.

Donors of sums between £20 and £100 are :—W. H. Allen, Sons and Co., Ltd.; Anglo-Iranian Oil Company, Ltd.; the late Sir John A. F. Aspinall ; Babcock and Wilcox, Ltd.; Mr. Ivon Braby ; British Compressed Air Society ; City and Guilds of London Institute ; The Worshipful Company of Clothworkers ; Messrs. Coode, Wilson, Mitchell and Vaughan-Lee ; the late Sir Archibald Denny ; the late Sir John Dewrance ; Sir Alexander Gibb ; Glenfield and Kennedy, Ltd.; Alfred Herbert, Ltd.; Messrs. C. S. Meik and Halcrow ; Messrs. Mott, Hay and Anderson ; Mr. Bernard Price ; Mr. William Reavell ; Messrs. Rendel, Palmer and Tritton ; Tunnel Portland Cement Company, Ltd.; The Rt. Hon. Viscount Wakefield ; The Rt. Hon. Lord Weir ; Yarrow and Co., Ltd.

The number of subscribers of smaller amounts is 251. The committee appreciate that in many cases the sums given by smaller subscribers have meant as much to them as have the larger gifts from other sources.

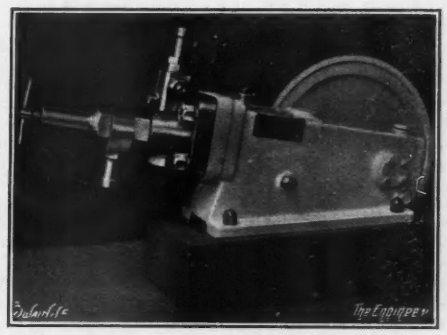
On the inauguration of the fund, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the Engineering Institute of Canada co-operated by forming committees to assist. These committees were merged subsequently into one body. This committee ultimately sent to the Executive Committee in London, £100 as the contribution of engineers in Canada and the United States. The committee greatly value this contribution, particularly as the conditions prevailing on the North American continent then were not at all favourable. It is a great tribute to the lasting character of Unwin's work.

The memoir, "The Life and Work of William Cawthorne Unwin," written for the committee by Mr. E. G. Walker, F.C.G.I., M.I.C.E., is an octavo volume of 254 pages, with 16 illustrations, and was published originally by the committee with a view to reducing expense. Owing to changes which took place subsequently in the arrangements of the executive, arrangements have now been made for the distribution of the memoir to be undertaken by George Allen and Unwin, Ltd., 40, Museum Street, London, W.C.1, who are now dealing entirely with the sale of the book. It is unfortunate that the outbreak of war followed in point of time very shortly after the printing of the book ; this hampered considerably the efforts to give it the publicity that it would have had under more normal conditions. It is hoped, however, that ultimately sales will prove sufficient to defray, at least, the greater part of the cost of the volume. In any case, there is every probability that, after deducting all legal and other expenses, the amount available for the endowment will exceed the £2500 originally aimed at.

The committee gives cordial thanks to Mr. G. A. Hicks for his work as honorary secretary, and for his services in connection with the printing and publication of the memoir, and to Mr. E. C. Walker who not only undertook voluntarily the considerable work involved in the writing of the biography, but is also the honorary treasurer of the fund. The committee also records its appreciation of the work of the late John Severs, who acted as joint honorary secretary until prevented by illness from continuing the work.

A Small Homogeniser

THE small homogeniser shown in the engraving is made by the Brush Electrical Engineering Company, Ltd., of Loughborough, and is intended to handle quantities of 8 to 12 gals. an hour. It comprises essentially a single cylinder, and a single-acting pump designed to operate at high pressures. The latter forces a pre-mixture of the product through an extremely fine orifice in the discharge valve at a very high velocity, resulting in a reduction of the particle size, and an efficient dispersion of these finely divided particles in the rest of the product. The reciprocating mechanism, a simple eccentric and connecting rod, is contained in a cast iron body, the mechanism being completely enclosed. A stainless steel plunger, coated with chromium by a special process to give a hard wearing surface operates through



SMALL HOMOGENISER

water washed and water sealed packings in a cylinder head also of stainless steel. This arrangement is claimed to eliminate the possibility of bacterial contamination. A non-return type of ball valve is fitted in a combined valve guide and cleaning port, situated immediately under the point of entry of the liquid to the machine giving a straight-through passage for cleaning. Discharge of the product takes place through the combined spring controlled discharge and homogenising valve comprising a nozzle-shaped seating, the small orifice in which is closed by a flat ended reversible spindle by the action of a powerful spring. The spring tension is adjustable by a handwheel, enabling the operating conditions to be varied within wide limits.

PROTECTION OF STEEL PLATES DURING NITRIDING.—A paint which has been found suitable for the protection of steel articles against the action of ammonia during nitriding processes is described in the Wild Barfield *Heat Treatment Journal*. It has the favourable characteristics of being readily applicable, quick drying, giving full protection without creeping on the surfaces, fast during the processing and easily removed afterwards. It is made up by taking one part of powdered tin and mixing it with two parts of the metal ester of polymerised oil.

Soil-Cement Paving for Secondary Roads in America

Treatment of local or natural formation soils with pulverised cement in order to produce a firm and durable surface for low cost, light-traffic roads, is among the numerous special methods of economic surfacing or paving for roads of this class which have been developed and practised in the United States. In the soil-cement construction, the native soil is pulverised in place, mixed with cement, and watered and rolled to produce a dense and hard crust or surface. More than 200 miles of road have been paved in this way, distributed over all parts of the country. This form of paving is recommended generally for roads on which the traffic does not exceed 500 vehicles daily.

The treatment is not rule-of-thumb or haphazard. Rather, as pointed out in a pamphlet of the Portland Cement Association, successful results—practical and economic—depend largely upon thorough survey of the soils on each project, followed by laboratory tests to determine the characteristics, and then construction methods governed by the laboratory findings. The laboratory work determines the amount of cement, moisture, and density required for any individual soil to ensure durability under the normal local conditions of repeated wetting and drying and freezing and thawing. Proper hydration of the cement is essential. Engineering control of the construction in the field is necessary, since the laboratory findings must govern the procedure. This control is provided by field tests supplementing careful supervision of the work.

In brief, the construction operations may be listed as follows:—The existing earth formation level for a new road—or the existing gravel or stone of an old road—is scarified to a depth of about 6in., and the scarified material is pulverised with suitable equipment. The specified amount of cement is spread evenly over the surface and mixed with the pulverised earth by means of disk harrows, field cultivators, and gang ploughs. After water has been sprinkled, this same equipment mixes the materials and water. The required density is then given by rolling with "sheepsfoot" rollers; a blade grader or road machine shapes the surface to the prescribed cross section, and a spike-tooth harrow scratches the surface before a final rolling with a smooth-wheel tandem roller. To prevent rapid evaporation or drying, the finished surface is covered for a short time with damp straw, hay, or earth.

Three factors necessary for successful results are determined by the laboratory tests: Cement content, moisture content, and density. The roadway should be finished to the specific gradients and cross section before soil sampling is begun. Thus muck, peat, or other unsatisfactory materials will have been replaced with materials of average quality. After a visual survey or inspection to identify the general types of soil, supplemented by occasional shallow test pits, preliminary samples of 5 lb. weight are taken from test holes 6in. deep—the usual depth of treatment—at intervals of 100 to 1000ft., depending upon variations in the soils encountered. These samples, properly identified, are sent to the laboratory and tested for grain size, the liquid, plastic, and shrinkage limits, and the field moisture equivalents. Soil maps and sections are prepared from the records thus obtained.

Samples of 200 lb. weight of the soils selected for treatment are then used in making soil-cement tests which determine the moisture-density relations of the soil alone, and mixed with different proportions of cement. To determine the durability of mixtures compacted at optimum moisture to maximum density, the several specimens are subjected to repeated freezing and thawing cycles and wetting and drying cycles. Laboratory methods for these various tests have been developed by the United States Bureau of Public Roads and the American Society for Testing Materials.

Satisfactory hardness and durability, as shown by low soil-loss in these tests, indicate the field-control factors required for successful work. For use in construction operations, a cement content by percentage of volume is specified, 10 per cent. being a very general proportion, but ranging between 6 and 12 per cent. Where cuttings penetrate soils of very high clay and colloidal content, requiring 14 per cent. or more of cement for satisfactory hardening, it will be wise to consider the possible economy of bringing in from borrow pits other soils which harden with average cement contents of about 10 per cent. Earthwork operations may be so organised as to place the lighter soils over heavy soils at little increase in cost. A common average for construction conditions is a cement content of 10 per cent. by volume, an optimum moisture content of 12 per cent., and a density of 115 lb. per cubic foot. These factors are used in estimating the quantities of cement and water for the work, and in preparing the specifications. A field laboratory is provided to enable the engineer in charge to carry out his field tests for control of moisture and density.

In the following condensed description of construction operations, the equipment, force, and procedure mentioned may average from 1000 to 1500ft. of roadway 22ft. wide (or 2400 to 3700 square yards), and 6in. thick, per ten-hour working day. Experienced crews can exceed these averages, which apply to both contract and day-labour work. The personnel and crew would include the following: Engineer in charge, soil engineer and assistant, construction superintendent, foreman, timekeeper, 5 or 6 semi-skilled labourers to operate tractors and other machinery, 15 to 20 men to drive motor lorries and handle cement, &c.

The minimum machinery equipment for the above average progress of work, all of ordinary types available and owned by most contractors, will be somewhat as follows, modified according to such other suitable or alternative equipment that might be available:

1 Subgrade (or formation) rooter; or an adjustable scarifier on a power road machine.
2 offset disk harrows, 9ft., with 24in. disks.
6 1½-ton motor lorries.
4 tractors of 35 or 40 H.P.
2 heavy-duty 8ft. spring-tooth field cultivators.
1 heavy duty gang-plough with 14in. to 18in. mould board with power control.
1 pressure distributor for sprinkling water, 1000 gals. capacity, to sprinkle at rate of 100 gals. per minute.
1 feeder tank or truck.
1 spike-tooth harrow, teeth not more than 1½in. apart.
1 light road patrol machine with 10ft. blade; power operated.
2 double-drum sheepsfoot rollers.
1 self-propelled, smooth-wheel tandem roller.

Rotary tillers have been used successfully in place of the cultivators, and are operated by the power take-off on the tractors. The sheepsfoot rollers will be designed for unit pressures of 50 to 100 lb. for sandy soils, 100 to 200 lb. for sandy loams and light clay loams, and 200 to 400 lb. for heavy clays and soils containing considerable aggregate; the area of the tamping feet will be respectively 8 to 12 square inches, 7 square inches, and 5 to 6 square inches for the light and heavy soils. The weight of the smooth-wheel roller also will be about 3 to 5 tons for sandy soils, 5 to 8 tons for sandy loams and light clay loams, and 8 to 12 tons for heavy clays. A broom drag is helpful for the finishing surface on some soils, but may be classed as optional.

Surveying, levelling, setting out, staking, and earthwork up to finished surface and cross section will be as in other kinds of road work. The series of operations for surface treatment or paving with soil-cement begins with the scarifying of the surface for a distance of about 1500ft., or sufficient for two days' work on the treatment. The teeth of the machine are adjusted to cut to a depth of 5½in., the additional ½in. being obtained during pulverising and mixing. The gang plough then makes a trip around the edges, throwing material towards the centre. Offset disk-harrows begin the pulverising, the tractor driver controlling the amount of opening of the disks. With this work half completed, the gang plough covers the entire section, bringing up bottom lumps for pulverising. The surface is then shaped by the motor-operated grader or road machine. If there is a rainy season, this finished surface may be protected by a covering of canvas or waterproof paper. The length of road pulverised should not be more than can be given complete treatment within two days.

Sacks of cement are spotted, or distributed, on the road according to the quantity requirements, and are emptied by hand, the cement being spread by rakes or by a spike-tooth harrow. Bulk cement may be used, if approved by the engineer. The cultivators then begin the mixing, one machine working on the central portion, and the other working on the sides. This operation is supplemented by the gang plough until the free cement has been incorporated thoroughly with the soil. The thoroughness of mixing will be checked by cutting inspection trenches across the road at intervals and noting the colour and appearance of the material.

Cement and soil can be mixed without forming cement balls, provided the moisture does not exceed the prescribed optimum of the soil-cement mixture by more than two. Preferably, the moisture in the soil should be one or two points below the optimum to give the most efficient mixing. Water is applied by a pressure distributor having a spray bar or pipe the full width of the paved road. If the bar covers only half the width, care must be taken not to leave a dry line along the middle. For effective sprinkling, it is essential to have a check on the capacity of the pumping, hauling, and distributing equipment. With friable soil, 1 gal. per square yard on each application can be handled, reducing this to about a ¼ gal. near the end of the sprinkling.

Each sprinkling is followed by the cultivators and disk harrow, to give a thorough mixing of the water with the dry soil-cement material. Gravity distributors or sprinklers are not satisfactory, especially as to uniformity of distribution and the application of small amounts of water. Effectiveness of the watering operation is checked by again cutting shallow trenches across the road, and noting the condition of the material. In general, the amount of water applied should be slightly more than the optimum specified, to provide for some loss by evaporation. Samples taken during the operation will be examined and tested in the field laboratory as a check on the construction operations.

After this intimate mixing, the surface is rolled transversely and longitudinally with the sheepsfoot rollers. In very sandy soils, however, which offer little resistance to compacting, rollers of this type cannot be used, even with large feet and low unit pressure. Such soils can be compacted effectively by rolling with pneumatic-tyred construction equipment—motor lorries, &c. As the sheepsfoot rollers leave damp compaction planes on their last passes, these are broken up by the passage of a spike-tooth harrow hauled by a tractor, the teeth being so adjusted as to penetrate just below the firm planes. Final rolling is then done with the smooth-wheel tandem power roller, leaving a hard, dense, and smooth crown and surface when the soil-cement mixture is finished at optimum moisture.

To prevent evaporation during a seven-day hydration period for the cement, the finished road surface is covered with earth, straw, or hay, this material being kept damp so that evaporation will occur from the covering, and not from the road surface. After seven days, the cover is removed and the road is opened to traffic for three or four weeks, a careful inspection being then made to determine the smoothness and finish. Slight deficiencies may be smoothed up with a light bituminous covering, applied after the surface has been cleaned of dust by a power broom and blower. A prime coat of 0·2 gal. per square yard may be followed by a coat of 0·3 gal. on which pea gravel or fine stone is spread and rolled in. A similar covering may be used as a protection against winter weather.

Although costs of foreign work form no criterion of general construction expenses, it may be noted that on some 200 projects carried out, with roads 16ft. to 22ft. of paved width, the construction costs have ranged from £680 to £1600 per mile, with an average of £1020, or 22d. per square yard. In this average, the cement cost was 12d.; treatment or processing, 8d., and water, 1d. per square yard. While the description of the treatment may appear rather complicated, in fact the operations are quite simple and such as are familiar to engineers and contractors on road work.

Industrial Scientists' Conference

A conference on "The Problems of the Industrial Scientist," convened by the Association of Scientific Workers and the British Association of Chemists, will be held on Saturday, March 9th, 1940, commencing at 2 p.m., in the lecture hall of the Pharmaceutical Society, 17, Bloomsbury Square, W.C.1. All scientific workers, and others interested, are cordially invited to attend and participate.

Professor F. G. Donnan, C.B.E., F.R.S., will be in the chair. Mr. Hugh Linstead, O.B.E., of the Pharmaceutical Society, will open the proceedings with a general survey of the problems of scientists employed in industry. This will be followed by a series of short factual papers and discussions on the following subjects:—

1. "Salaries, increments, overtime payments, pensions, and superannuation schemes" (Mr. J. Stewart Cook, B.Sc., A.R.C.S., of the London Section Committee of the British Association of Chemists).
2. "Methods of securing employment, unemployment insurance schemes for workers over the salary limits, compensation for accidents" (Mr. C. B. Woodley, F.C.R.A., F.C.I.S., of the British Association of Chemists).
3. "Rights of Publication" (Mr. H. T. Rhodes, M.I.E.I., of the British Association of Chemists).
4. "Holidays, opportunities for study, the Five-Day Week" (Mr. J. L. Pinder, B.Sc., F.I.C., of the Association of Scientific Workers).
5. "The Position of the Assistant" (Mr. R. Peter, an assistant chemist).
6. "Problems of contracts, the right to seek alternative employment, adequate notice of termination of employment" (Mr. F. W. Adams, B.Sc., Ph.C., barrister-at-law, of the Pharmaceutical Society).

At the conclusion of these discussions, Professor J. D. Bernal, F.R.S., will sum up the discussions as a whole and the conference will then consider the possibility of adopting a "programme" for scientific workers in industry.

Similar conferences are being held at:—

Liverpool, at 6.30 p.m., on March 4th, 5–6, Bluecoat Chambers, Liverpool, 1.
Manchester, at 3.0 p.m., on March 16th, Chemistry Lecture Theatre, the University.
Birmingham, date to be announced later.

Following the regional conferences, it is intended, at a later date, to hold a National Conference to review the data and resolutions resulting from them and to decide on the final form of the "programme" and on steps to be taken to work for its acceptance.

Continental Air Services.—Under a pooling arrangement between the Dutch and Danish air liners, it is reported that sixteen air services will be flown each week between London, Amsterdam, and Copenhagen.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer.

The American Market

During January a slight recession in activity was noted in the United States iron and steel market. The production of pig iron, for instance, was 3,600,000 tons against 3,768,336 tons in December; and the number of furnaces in blast dropped from 191 at the beginning of the year to 179 on February 1st. The general appearance of the market is, however, not discouraging. At the moment new buying is rather light but there is a steady flow of small orders which, it is said, amount in tonnage to about 50 per cent. of the work which has been completed. The stockholding firms carried over into this year considerable reserves of finished steel and have not found it necessary yet to enter upon any replenishment buying. It is expected, however, that the motor industry will come on the market during the next few weeks for considerable tonnages and their seasonal buying is likely to put a different complexion upon the situation before the end of the first quarter. There is a general expectation that the requirements of the British and French Governments this year will be so large that it will be necessary to add to their present considerable purchases. A large tonnage of pig iron was bought by Great Britain in December, and shipments against these contracts are now proceeding. In addition it is reported that contracts for 200,000 tons of semi-finished steel for shipment to Great Britain have been divided amongst the principal American steelmakers. In other departments, however, business is rather poor. Many of the iron foundries, for instance, are working only three or four days a week, and are understood to have large stocks on hand. The steel industry as a whole is operating at about 69 per cent. of capacity, but some observers are inclined to think that before new buying develops it may fall to as low as 60 per cent. The output of open hearth and bessemer steel in January reached 5,017,588 tons, the December production being 5,164,420 tons. For four consecutive months the output has been over 5 million tons. The most outstanding recent order for the domestic trade has been one for 16,000 tons of steel for a 12¾in. pipe line which was split between two makers. This, and one or two other substantial orders, has put the pipe and tube mills in a comfortable position. Reports are current that the prices of concrete reinforcing bars have been shaded in the western districts and that some price cutting has occurred in the sheet market. It is expected that an order for 50,000 tons of automobile sheets will be released so soon as a controversy regarding the extras for coiling has been settled. There has been a revision of extras on galvanised sheets and wire as well as on stainless steel sheets and bars.

The Pig Iron Market

Conditions in the pig iron market have not materially altered. The pressure to obtain supplies is unrelaxed and in many cases consumers are pressing for accelerated delivery in spite of the fact that the makers are already straining production to the limit. Arrangements have been made to import considerable quantities of pig iron from abroad, and this should afford relief to the consuming industries at a not distant date. The pressure is probably greatest in the basic pig iron department, and the heavy output of steel is absorbing the whole production of basic pig iron almost so soon as it is produced. Not unnaturally, the steelmakers who have to plan well ahead are becoming somewhat apprehensive regarding their forward supplies, but arrangements which are in course of being made should allay this nervousness. The Control is carefully supervising the distribution, and has met with a great measure of success in its efforts to keep the various works supplied. The demand for hematite is also increasing. In some districts smelting operations were hindered by the severe weather in January, but raw materials are now coming forward normally and the arrears which resulted from a slowing down of output are being rapidly overtaken. On the North-East Coast production is concentrated upon basic qualities and the foundries are being supplied with Midland irons. When this change-over was first made some consumers found it difficult to adjust their works' practice, but so far as can be seen these troubles have been overcome and they are now accustomed to the use of Northants and Staffordshire irons. In the Midland district the demand is still principally for foundry iron of low phosphoric quality. The production of this class is barely sufficient to meet the requirements of consumers, many of whom, including the engineering firms engaged upon Government work, are having to supplement their supplies by purchases of hematite. In Scotland the full production of basic and hematite iron is being rapidly taken up and the steelworks would be glad to receive additional supplies. The demand for the foundry qualities, however, is irregular and is likely to remain so until the light castings industry is able to absorb larger tonnages than at present. These foundries are, with a few exceptions, working short time, and disappointment is expressed that they have not been supplied with more war work. The active demand for hematite has so far been satisfied, but the stocks with which the makers entered this year have been greatly depleted.

Scotland and the North

The increasing demand for iron and steel materials is giving cause for anxiety to the Scottish steelmakers. Already they are working at as near capacity as supplies of raw materials will permit, and it is practically impossible for them to cope with the volume of orders which is being pressed upon them. Unless an order comes within one of the priority categories and is of a particularly urgent character consumers have little chance of getting it accepted and the works are concentrating upon reducing the congested state of their order books. As fast as material is produced it passes into consumption, but even so, and in spite of the heavy deliveries, the works are in arrears against their contracts. Expectations that imports of finished steel will be arranged are current, and these should do something to meet the requirements of consumers. The constructional engineering trades are the largest consumers of joists and sections, and this industry is employed principally upon Government work and upon extensions to munitions works, factories, and aeroplane hangars. The shipbuilding industry is not far behind the constructional engineers in its requirements of steel of various descriptions. All the shipbuilding yards are fully employed and are daily absorbing huge tonnages of steel. The general engineering works in Scotland are engaged upon important jobs for the Government, and their consumption is at an almost record rate. The locomotive builders also have in hand big contracts both for home and overseas customers and the foundry makers are working very near to capacity. The re-rolling works are in a better position than during the middle of January since supplies of billets are coming forward more freely and the production of bars, angles, strip, &c. has been considerably speeded up. The majority of these works have sufficient orders on their books to keep them well employed for several months, and are reluctant to enter upon fresh commitments. Little export business is considered, and when it is far forward delivery dates are mentioned. In the Lancashire market the pressure for deliveries of all descriptions of steel is unabated. The works are doing their best to meet consumers' requirements, but the demand is in excess of the supply for the time being. There is a particularly heavy request for plates, and it is difficult to find a works in a position to accept new business. Bright drawn steel bars, wire, and alloy steels are also in strong request, and large tonnages are passing into use.

The Midlands and South Wales

So heavy is the rush to place orders with the steelworks that consumers are willing to accept indefinite delivery so long as the business is accepted. For the most part the steelmakers prefer not to add to their already congested books, but where priority material is concerned most of them will do so, although they will not commit themselves as to when delivery will be possible. The constructional engineering industry has probably never been so well employed as at present, and although in January there was some slackening as a result of seasonal conditions, this has now passed, and the demand for all descriptions of structural steel is again expanding. In consequence the steelworks are dropping behind in their contract deliveries. The position in the plate department is stringent since not only are plates required in heavy quantities by the shipyards, but almost every industry using this class of steel is in need of more than can be obtained within a reasonable period. The re-rolling works are recovering from the stringent conditions which developed during part of January and with transport becoming more normal are receiving better supplies of semis. The works have full order books and are anxiously awaiting larger supplies of billets and sheet bars. The British Iron and Steel Corporation has arranged for considerable supplies from abroad and once the re-rollers obtain their allocations they should be in a position to reduce the tonnage of overdue deliveries. A feature of the market for a long time past has been the insistent demand for colliery steel. The scarcity of wood props has led to arrangements being made with the Continental steel makers for the supply of a large tonnage of joists which will be worked-up into pit props. A steady business is passing in bright drawn and alloy steels with the engineering plant engaged upon Government work. In South Wales the steel works are operating at a high rate of capacity. The production of heavy finished steel, large as it is, is passing immediately into consumption. In the tinplate industry there is a shortage of steel and as a result the rate of production has receded slightly. It is anticipated, however, that this will be only a temporary phase as large arrivals of foreign sheet bars are expected to be distributed shortly. The tinplate works are in a particularly favourable position and have orders for well over ten million boxes in hand. The demand from the shipyards for steel is unrelaxed and the constructional engineering industry in that district has sufficient work on on hand to ensure employment for some months.

Overseas Trade Opportunities

The Department of Overseas Trade, Gt. George Street, London, S.W.1, announces that the following contracts are open for tender. Local representation is essential:—Wellington, N.Z. Public Works Department, supply and delivery of one 7½-ton single motor, travelling crab operated from the gate bridge; supply and delivery c. and f. Auckland of one 40-ton overhead travelling crane for indoor operation in the sub-station workshop at Mount Roskill, Auckland, for the lifting and transport of 10,000 kVA single phase transformers and for smaller machinery and apparatus. The hoisting and longitudinal traverse motion is to be operated by electric motor, controlled from floor level; one 5-ton overhead single motor travelling crane for indoor operation at the same sub-station switchroom (Wellington, March 5th); supply and delivery of a 3000 kVA transformer bank for Wairoa sub-station, Palmerston North District (Wellington, April 9th). Indian Stores Department, supply and delivery of buffers for the North Western Railway; screw couplings (New Delhi, March 6th). Mosul Electricity and Water Board, quantities of electric lamps, chlorinating plant; cast iron water pipes, valves, and one steel tank having a capacity of 20,000 gals. (Bagdad, March 16th). South Africa, Union Tenders and Supplies Board, supply and delivery of steaming ovens (Pretoria, March 14th). South African Railways and Harbours Administration, supply of grinding wheels (Johannesburg, March 14th); quantities of steel plate (Johannesburg, March 26th); one 2-ton, two 5-ton, and two 10-ton capacity overhead electric travelling cranes for New Foundry, Salt River, Workshops; wheels and axles; bar steel (Johannesburg, April 1st); structural steel for bridgework (Johannesburg, April 4th). South Africa Union Tender and Supplies Board, supply and delivery of a vertical steam boiler (Pretoria, March 14th). Argentine Sanitary Works Department, supply of cast iron pipes in quantities of 400 m. to 150,000 m. and varying diameters (Buenos Aires, March 5th). The Ford Motor Company, Ltd., states that, in spite of difficulties occasioned by the war in the last quarter of 1939, exports from the Ford Works, Dagenham, to the Argentine last year were 260 per cent. greater than in 1938.

Copper and Tin

The world market for copper has become somewhat firmer, but this, of course, has not affected conditions in Great Britain where prices are fixed and supplies are rigidly controlled. In the United States the demand which had slackened very considerably revived a week or so ago and since then has gathered strength. Buying reached an unexpected degree of activity and it was reported that in one day over 60,000 short tons of copper were sold. The irregularity in the market has disappeared and the general domestic quotation is now 11·50c. Even at this price producers are restricting their sales. It is somewhat difficult to see the reason for this rapid improvement in the American market, but it must be assumed that the consumption of copper has been on a heavier scale than was understood to be the case, and that notwithstanding the heavy purchases earlier in the year the metal has been largely absorbed. It had been stated that consumers were not expected to enter the market on any considerable scale until towards the end of March. It is not anticipated that this buying movement will be maintained for any length of time since usually in America when consumers come on the market in such force they buy sufficient copper to cover their requirements for several weeks, with the result that the improvement is generally followed by a dull period. The export price has moved up largely in sympathy with the home price, and stands now at about 11.875c. f.a.s. There has been a certain amount of buying, principally by Italy and the Balkan States. . . . The International Tin Committee met on February 26th, and decided to reduce the quota by 40 per cent., that is from 120 per cent. to 80 per cent. This news was known after the market. But dealings which then took place brought about a rise in price to £254 for three months, or about £9 10s. increase on the previous official figure. The market had expected a reduction in the quota to about 100 per cent. of the standard tonnage, but the decision to cut it to 80 per cent. came as a surprise. For the time being there is no shortage of tin, in fact there is plenty of the metal about, and export licenses have been granted rather freely of late. It remains to be seen whether the cut in production and the rise in price will check the overseas demand. The impression in the London market is that the reduction has been too drastic, and that for a time prices will show a tendency to rise. In that event it seems possible that the International Tin Committee will have to revise its decision and again increase output.

Lead and Spelter

The steady demand from consumers continues unrelaxed. Most of the firms making lead products are engaged upon war work and experience no difficulty in obtaining their full requirements. Those firms having work of a commercial character, however, are not so well catered for. This, however, is understandable in war time and there is little discontent expressed at the attitude of the Control towards this latter class of consumer. Although licences are carefully scrutinised a certain amount of lead has been released for the manufacture of products intended for export as it is realised that it is necessary to extend the export trade of the country as much as possible. There seems little doubt now but that the supplies of Empire lead will be sufficient for this country's requirements, even on a war basis. The situation in neutral countries seems to vary considerably. Generally speaking, prices have fallen from the high levels to which they rose at the beginning of the war and are not very dissimilar to the British official maximum quotations. The figures for the Mexican exports for September last totalled just over 9000 tons which included 6950 tons for the United States. Norway took 432 tons and Sweden 361 tons. . . . The demand for spelter is at a particularly high level but is being fully met by the Control. Now and again consumers say they have a difficulty in getting certain descriptions, and recently there has been some difficulty in obtaining high grade spelter. Supplies of G.O.B. qualities however are freely available. The consuming industries for the most part are fully employed upon Government orders and the brassmakers in particular are taking good quantities of the metal. The galvanising industry is the largest consumer, and is likely to remain so whilst the galvanised sheet works are so well employed. In the United States the market has developed a stronger tone and it is expected that prices will shortly be advanced.

SWISS RAILWAY PROGRAMME.—It is reported that the Swiss Federal Railways intend to spend a considerable sum on new rolling stock and line improvements during the coming year. Some improvements include the double tracking of the Brunnen–Fluelen and Taverne–Lugano sections of the St. Gotthard line and the beginning of a connecting line in Geneva between Cornavin and Eaux Vives stations.

Current Prices for Metals and Fuels

Official maximum home trade prices, per ton, delivered. *Joists, Sections, Bars and Plates are subject to a rebate of 15s. to home users purchasing only from Associated British Steelmakers. †Export prices are for approved specifications and destinations.

PIG IRON.

Foundry home prices, except for Scotland, less rebate of 5/-. (*D/d Teeside Area.*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	6 7 6	—
„ No. 1	6 7 6	—
Cleveland—		
No. 1	5 13 6	—
No. 3 G.M.B.	5 11 0	—
No. 4 Foundry	5 10 0	—
Basic	5 4 6	—
MIDLANDS—		
Staffs— (*Delivered to Black Country Station.*)		
North Staffs Foundry	5 13 0	—
„ „ Forge	5 10 0 to £5 12 0	—
„ „ Basic	5 4 6	—
Northampton—		
Foundry No. 3	5 10 6	—
Forge	5 7 6 to £5 9 6	—
Derbyshire—		
No. 3 Foundry	5 13 0	—
Forge	5 10 0 to £5 12 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	6 7 6	—
No. 1 Foundry, ditto	5 15 0	—
No. 3 Foundry, ditto	5 12 6	—
Basic, d/d	5 4 6	—
N.W. COAST—		
Hematite Mixed Nos.	6 7 6 d/d Glasgow 6 13 0 „ Sheffield 6 19 0 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export, nominal. £ s. d.
LANCS. AND YORKS—		
Crown Bars	12 17 6	12 7 6
Best Bars	13 2 6	12 17 6
MIDLANDS—		
Crown Bars	12 17 6	12 7 6
Marked Bars (Staffs)	15 17 6	—
No. 3 Quality	11 7 6	—
No. 4 Quality	11 17 6	—
SCOTLAND—		
Crown Bars	12 17 6	12 7 6
Best	13 2 6	12 17 6
N.E. COAST—		
Crown Bars	12 17 6	12 7 6
Best Bars	13 2 6	12 17 6
Double Best Bars	13 17 6	13 7 6
NORTHERN IRELAND AND FREE STATE—		
Crown Bars, f.o.q.	13 10 0	—

STEEL.

	*Home. £ s. d.	†Export. nom. £ s. d.
LONDON AND THE SOUTH—		
Angles	12 10 6	12 2 6
Tees	13 10 6	13 2 6
Joists	12 10 6	13 2 6
Channels	12 15 6	12 7 6
Rounds, 3in. and up	13 10 6	13 2 6
„ under 3in.	14 5 6‡	13 9 0
Flats, under 5in.	14 5 6‡	13 9 0
Plates, ½in. (basis)	12 15 6	12 2 6
„ 5/16in.	13 0 6	12 7 6
„ ½in.	13 5 6	12 12 6
„ 5/8in.	13 10 6	12 17 6
Un. 5/16in. to and incl. 6 lb. per sq. ft. (8-G.)	14 2 6	15 0 0
Boiler Plates, ½in.	13 10 6	13 12 6
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	12 8 0	12 2 6
Tees	13 8 0	13 2 6
Joists	12 8 0	12 2 6
Channels	12 13 0	12 7 6
Rounds, 3in. and up	13 8 0	13 2 6
„ under 3in.	14 3 0‡	13 9 0
Plates, ½in. (basis)	12 10 6	12 2 6
„ 5/16in.	12 18 0	12 7 6
„ ½in.	12 3 0	12 12 6
„ 5/8in.	13 8 0	12 17 6
Un. 5/16in. to and incl. 6 lb. per sq. ft. (8-G.)	14 0 0	15 0 0
Boiler Plates, ½in.	13 8 0	13 12 6
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	12 8 0	12 2 6
Tees	13 8 0	13 2 6
Joists	12 8 0	12 2 6
Channels	12 13 0	12 7 6
Rounds, 3in. and up	13 8 0	13 2 6
„ under 3in.	14 3 0‡	13 9 0
Flats, 5in. and under	14 3 0‡	13 9 0
Plates, ½in. (basis)	12 13 0	12 2 6
„ 5/16in.	12 18 0	12 7 6
„ ½in.	13 3 0	12 12 6
„ 5/8in.	13 8 0	12 17 6
Un. 5/16in. to and incl. 6 lb. per sq. ft. (8-G.)	14 0 0	15 0 0
Boiler Plates, ½in.	13 8 0	13 12 6

STEEL (*continued*).

	*Home. £ s. d.	†Export. £ s. d.
GLASGOW AND DISTRICT—		
Angles	12 8 0	12 2 6
Tees	13 8 0	13 2 6
Joists	12 8 0	12 2 6
Channels	12 13 0	12 7 6
Rounds, 3in. and up	13 8 0	13 2 6
„ under 3in.	14 3 0‡	13 9 0
Flats, 5in. and under	14 3 0‡	13 9 0
Plates, ½in. (basis)	12 10 6	12 2 6
„ 5/16in.	12 15 6	12 7 6
„ ½in.	13 0 6	12 12 6
„ 5/8in.	13 5 6	12 17 6
Un. 5/16in. to and incl. 6 lb. per sq. ft. (8-G.)	14 0 0	12 12 6
Boiler Plates, ½in.	13 8 0	13 12 6
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	12 8 0	12 2 6
Tees	13 8 0	13 2 6
Joists	12 8 0	12 2 6
Channels	12 13 0	12 7 6
Rounds, 3in. and up	13 8 0	12 2 6
„ under 3in.	14 3 0‡	13 9 0
Flats, 5in. and under	14 3 0‡	13 9 0
Plates, ½in. (basis)	12 13 0	12 2 6
„ 5/16in.	12 18 0	12 7 6
„ ½in.	12 3 0	12 12 6
„ 5/8in.	13 8 0	12 17 6
Un. 5/16in. to and incl. 6 lb. per sq. ft. (8-G.)	14 0 0	15 0 0

IRELAND—F.O.Q.—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	12 8 0	12 10 6
Tees	13 8 0	13 10 6
Joists	12 8 0	12 10 6
Channels	12 13 0	12 15 6
Rounds, 3in. and up	13 8 0	13 10 6
„ under 3in.	14 3 0‡	14 5 6
Plates, ½in. (basis)	12 10 6	12 13 0
„ 5/16in.	12 15 6	12 18 0
„ ½in.	13 0 6	13 3 0
„ 5/8in.	13 5 6	13 8 0
Un. 5/16in. to ¼in. incl.	14 0 0	15 2 6

‡ *Rounds and Flats tested quality ; untested, 3s. less.*

OTHER STEEL MATERIALS

Sheets.	Home. £ s. d.	Export, f.o.b. £ s. d.
11-G. and 12-G., d/d	16 10 0	11-G. to 14-G. 15 7 6
13-G., d/d	16 17 6	15-G. to 16-G. 15 17 6
14-G. to 20-G., d/d	17 5 0	17-G. to 18-G. 16 2 6
21-G. to 24-G., d/d	17 10 0	19-G. to 20-G. 16 7 6
25-G. and 26-G., d/d	18 5 0	21-G. to 24-G. 17 0 0

The home trade sheet prices are for 4-ton lots and over ; 2-ton to 4-ton lots, 7s. 6d. per ton extra ; and under 2-ton lots to 10-cwt., £2 12s. 6d. per ton extra.

Galvanised Corrugated sheets, basis 24-G.—

Home.	£ s. d.
4-ton lots and up	20 0 0
2-ton to 4-ton lots	20 7 6
Under 2 tons to 10 cwt.	22 12 6

Export : General, £19 10s. 0d., f.o.b., 24-G. basis.

TIN-PLATES—
20 by 14 basis, f.o.t., Bristol Channel Ports, 24s. 9d.
Tin-plate Bars, d/d Welsh Works, £9 5s.

BILLETS—100-ton lots and over, 35 to 100 tons, 5s. extra ; less than 35 tons, 10s. extra.

	£ s. d.
Soft, untested	9 7 6
„ (up to 0·25% C.), tested	9 12 6
Basic (0·33% to 0·41% C.)	9 17 6
„ Medium (0·42% to 0·60% C.)	10 10 0
„ Hard (0·61% to 0·85% C.)	11 0 0
„ „ (0·88% to 0·99% C.)	11 10 0
„ „ (over 0·99% C.)	12 0 0
Rails, Heavy, 500-ton lots, f.o.t.	11 3 0
„ Light, f.o.t., up to and including 25 lb. per yard	13 6 6

FERRO-ALLOYS.

	Per Ton.	
Tungsten Metal Powder	5/2½ per lb.	
Ferro-Tungsten	5/1 per lb.	
Ferro-Chrome, 4 p.c. to 6 p.c. carbon	£39 10 0	(nominal)
„ „ 6 p.c. to 8 p.c.	£38 10 0	(nominal)
„ „ 8 p.c. to 10 p.c.	£38 10 0	(nominal)
„ „ Max. 2 p.c. carbon	£59 0 0	(nominal)
„ „ „ 1 p.c. carbon	£60 0 0	(nominal)
„ „ „ 0·5 p.c. carbon	£71 0 0	
„ „ „ carbon-free	1/2d. per lb.	
Metallic Chromium	3/6 per lb.	(nominal)
Ferro-Manganese (loose), 76 p.c.	£18 to £19	home
„ Silicon, 45 p.c. to 50 p.c.	£18 10 0	
„ „ 75 p.c.	£28 0 0	
„ Vanadium	15/6 per lb.	
„ Molybdenum	6/- per lb.	
„ Titanium (carbon-free) 20/25p.c.	1/3 per lb.	
Nickel	£190 to £195 per ton	
Cobalt	8/7 per lb.	

NON-FERROUS METALS.

(*Official Prices, February 27th.*)

COPPER—	
Electrolytic	£62 d/d buyers' premises
Billets, 3in. to below 4in.	£65 „
Cakes, up to 800 lb.	£62 12 6 „
Cathodes	£61 10 0 „
Wire rods	£65 10 0 „
Sheets, Hot rolled	£96 0 0 „
	Home.
Tubes, Solid Drawn (basis)	14½d.
„ Brazed (basis)	14½d.
BRASS—	
Ingots, 70/30, d/d Birmingham	£53 to £54
	Home.
Tubes, Solid Drawn 2/1 Alloy	13½d.
„ Brazed	15½d.
TIN—	
Cash	£254 10 0 to £254 15 0
Three Months	£254 10 0 to £254 15 0
SPELTER—	
G.O.B. Foreign	£25 15 d/d buyers' premises (duty paid).
G.O.B. domestic, incl. secondary or re-melted zinc	£26 10 d/d buyers' premises.
LEAD—	
Pig lead, foreign	£25 d/d buyers' premises (duty paid).
Empire lead	£25 d/d buyers' premises
Aluminium Ingots (British)	£110 (net)

FUELS.

SCOTLAND

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—	
Navigation Unscreened	22/6 to 23/-
Hamilton Ell	23/-
Splints	24/-
AYRSHIRE—	
(f.o.b. Ports)—	
Steam	21/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	22/-
Unscreened Navigation	22/6 to 23/-
LOTHIANS—	
(f.o.b. Leith)—	
Hartley Prime	22/-
Secondary Steam	21/3

ENGLAND

SOUTH YORKSHIRE, DONCASTER—	
Hards	20/- to 21/-
Washed Smalls	17/- to 18/-
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	22/-
„ Second	21/-
„ Best Small	18/6
Unscreened	20/- to 21/-
DURHAM—	
Best Gas	22/6
Foundry Coke	29/3 to 30/-

SOUTH WALES

CARDIFF—	
Steam Coals :	
Best Admiralty Large	26/4 to 27/10
Best Seconds	25/10 to 27/4
Best Dry Large	25/4 to 27/4
Ordinaries	25/4 to 27/4
Bunker Smalls	19/4 to 22/4
Cargo Smalls	18/4 to 19/4
Dry Nuts	30/4 to 32/4
Foundry Coke	50/- to 60/-
Furnace Coke	39/- to 40/-
Patent Fuel	28/10
SWANSEA—	
Anthracite Coals	
Best Large	34/- to 36/6
Machine-made Cobbles	36/- to 43/-
Nuts	36/6 to 45/6
Beans	37/6 to 42/-
Peas	30/- to 31/-
Rubbly Culm	16/- to 17/-
Steam Coals :	
Large Ordinary	23/- to 26/-

FUEL OIL.

Inland consumption : supplies in bulk : exclusive of Government tax of 1d. per gallon (other than for use in Diesel-engined road vehicles).

D/d prices in London for supplies in bulk—	Per Gallon
Pool Fuel Oil	5½d.
Pool Diesel Oil	6d.

All supplies are now controlled by the Petroleum Board and all prices are on a day to day basis and subject to alteration without notice.

French Engineering Notes

(From our own Correspondent in Paris)

Post-War Manufacture

Immediately following the last war manufacturers were at a loss to know how to adapt themselves to peace conditions. The supply of war materials had devolved mainly on private works, many of which were largely extended and new ones erected. They were all more fully equipped. The production capacity was far in excess of previous normal requirements. There was no general plan of reorganisation and nothing to guide manufacturers in making full use of their increased facilities. The only obvious fact was that during the war there had been a vast importation of goods and machinery which makers believed they could henceforth supply themselves. Some firms went in for the manufacture of textile machinery; new factories that had been built for the production of war materials were turned over to agricultural machinery; machine tool makers expanded their production, and new industries were undertaken, usually under foreign licence or with patents ceded by Germany on account of reparations. Had there been some method in this activity it is probable that the industrial expansion would have avoided troubles that brought discomfiture to so many firms. The different branches of industrial production were eventually organised and permanently consolidated. This experience has led to a more cautious attitude towards the industrial policy to be followed after the present war. It is, of course, impossible to foresee what the conditions are likely to be. But a basis of appreciation is offered by the Government's proposal two years ago to make a complete inquiry into the national needs and the possibility of expansion in order to adapt production to these requirements. The same idea underlies a movement in favour of an "orientation of industry" which may eventually be co-ordinated by the Government. A start has been made by some branches of production, which are investigating national needs and new outlets for their products. If the war should last for any considerable time it is believed that a mass of information may be collected that will justify the Government in constituting an organisation for the "orientation of industry" in order to ensure that a further expansion of industry may be carried out rationally without risk of manufacturers embarking on enterprises that are doomed to failure. Nevertheless, conditions after the war can hardly be the same as they were 25 years ago. The bulk of armament production has not fallen on manufacturers as it did then, although big works have been practically requisitioned, and smaller makers are working as sub-contractors; but there is not the same extension of private factories which, however, are generally more fully equipped and are capable of an appreciably larger production than before. Having a monopoly of armament production, the state is making a great effort to increase it upon the initiative and under the direction of the Minister of Armaments, Monsieur Raoul Dautry, who is carrying out his task with remarkable success. New factories have been erected and machinery installed in an incredibly short time, and the work of increasing production continues. It cannot be known yet whether these concrete factories that have been built, and are still rising, in many parts of the country will have anything to do with civil production in the future. The State will not compete with industry, and it is therefore a question whether some of the factories will eventually be taken over for private enterprise. The problem of organising a return to civil production therefore remains.

Industrial Solidarity.

Practically all industries and all branches of each industry are so completely grouped for the protection of their interests that every facility is provided for carrying out plans in the general interest. Each branch has regional syndicates affiliated to a general syndicate which is the controlling body. Since the mobilisation, the normal conditions of industry have been changed to one of State control, which gives rise to complications that can best be adjusted by the general syndicates. A manufacturer may be called up for military service, or his technical staff may be mobilised, or for other reasons due to the war he may be unable to carry on his business, which therefore passes into other hands. This state of things is unfair to the manufacturer and is regarded as a social anomaly, while being detrimental to the national interest in time of war when there should be no interruption whatever to production. When formulating plans to increase production, the Government made a suggestion that manufacturers should collaborate in the execution of contracts, if necessary, and if one should need assistance by the temporary loan of a particular machine, for example, it should be provided by another who has no immediate need of that machine, and collaboration should be extended by an interchange among makers of practical knowledge and experience. In a word, it is argued that, particularly at the present time, there should be a complete solidarity in production. It is something upon these lines that the general syndicate of French electrical engineering contractors is inducing its affiliated members, numbering about 6000, to sign a "solidarity convention" which ensures mutual assistance in all cases where a firm finds itself in difficulties. In the first place, a contractor in such a situation may apply for aid to his regional syndicate which, if justified, will do what is necessary to enable him to carry on his work. No member signing the convention is allowed to take into his employment anyone from another signatory member without the latter's consent. Nor can he divert business from another man who finds himself in difficulties. If the latter requires it, the work can be executed for him by other members under the control of the regional syndicate. The interest of this solidarity convention lies not only in the actual conditions subscribed to, but more especially in indicating the trend of the social movement applied to industry, such as the provision of mutual aid that will give a sense of security to everyone concerned. The convention will continue in operation after the war.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

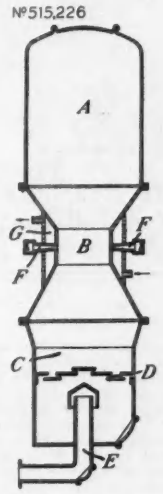
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

GAS PRODUCERS

515,226. May 27th, 1938.—IMPROVEMENTS IN GAS PRODUCERS, Thomas Frederick Hurley, Fuel Research Station, Blackwall Lane, East Greenwich, London, S.E.10.

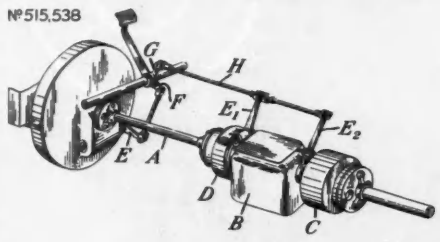
Down draught gas producers using solid carbonaceous fuels of the type in which a fuel receptable is mounted above a lower combustion chamber having a gas off-take, have certain disadvantages among which may be mentioned an inability to use fuel having a high volatile and/or ash content or to cope with varying loads. The object of the invention is to provide an improved construction of producer of this general type designed to remove these disabilities. According to the invention in the restricted throat portion itself there are provided one or more water cooled nozzles which may or may not project into the fuel bed. Optionally, the nozzles extend through a jacket surrounding the throat portion through which jacket water may be circulated for the purpose of cooling the nozzles. In the construction illustrated the fuel chamber A is shown connected through a throat portion B with a lower chamber C adjacent to the base of which is located a grate D which is in the form of a step grate. The gas is withdrawn by way of an offtake E opening at a position below the grate. For introducing air into the producer tuyeres or nozzles F which are water cooled are provided and they may project into the body of fuel. In the construction shown they pass through a water jacket G.—*November 29th*, 1939.



MOTOR CARS

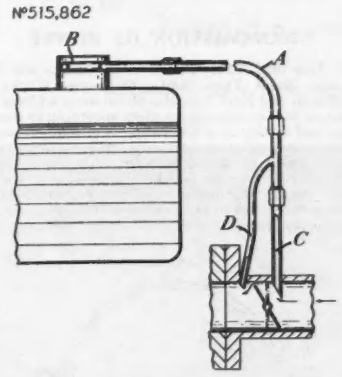
515,538. June 2nd, 1938.—GEAR CHANGE MECHANISM, Shelvoke and Drewry, Ltd., Letchworth, Hertfordshire, and Charles Kearns Edwards, Blythe House, Letchworth, Hertfordshire.

In a motor vehicle provided with a sliding spur gearbox the operation of changing gear requires a considerable degree of skill if excessive noise and danger of damage to the gearbox is to be avoided. The present invention provides a simple mechanism whereby gear changes can be effected smoothly and without noise and shock without the necessity for skill on the part of the driver. A gear-changing device in accordance with the invention is described by way of example with reference to the accompanying drawing. In the drawing the drive is transferred through an engine clutch by way of a shaft A to the gearbox B. From here it passes to the additional clutch C and so to the output shaft. Between the gear-box and the clutch a brake D is arranged which is normally off and by means of which the shaft A can be slowed down and stopped. The clutches and the brake are respectively operated by means of levers E, E_1, and E_2. The mechanism is controlled by means of the clutch pedal which carries two arms F and G. The arm F is pivotally connected to a link which is in turn connected to the lever E. The arm G is articulated to a link H which carries two slotted members. Pins on the levers E_1 and E_2 engage in the slots of the member on link H, so that depression of the clutch pedal, after a lag corresponding to the length of the respective slots, causes disengagement of the clutch and application of the brake D. As the link between E and F is not slotted the clutch is operated without any lag. The size of the two slots are so arranged that when the clutch pedal is depressed the mechanisms are operated in the following order: first the engine clutch is disengaged; next the additional clutch C is disengaged; and then the brake D is applied which brings the shaft A to rest together with any wheels in the gearbox which are connected to it. The clutch is of the multiple plate type which provides a slight residual drag when disengaged, causing the gear wheels connected to the output shaft to revolve slowly.—*December 7th*, 1939.



515,862. June 28th, 1938.—IMPROVEMENTS IN CARBURATION SYSTEMS OF INTERNAL COMBUSTION ENGINES, James Leandor Stephenson, 13, Mayville Road, Leeds, 6.

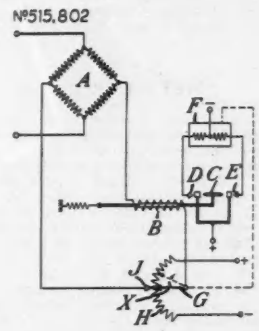
The object of this invention is to provide an improved method of, and means for, introducing moisture in the form of steam to the carburation systems of internal combustion engines. The accompanying drawing shows one embodiment by way of example. A steam pipe A runs from a steam trap B on the top of the engine radiator header tank, or other steam supply means to the carburettor outlet. The pipe is led into the outlet at two (or more) points in the form of inlets before and after the throttle valve. To facilitate the steam flow, the ends of the inlets are cut at an angle to open in the direction of the mixture flow. In this manner there is a tendency to create a partial vacuum at the steam inlets and so draw the steam along the feed pipe. In practice it is found that invariably the best results are obtained by extending the larger inlet C into the outlet for about $\frac{1}{2}$ to $\frac{1}{4}$ of the bore and locating it as close to the throttle valve as is practicable. The smaller inlet D need only project a short distance into the outlet. By using two steam inlets with the larger bore before the throttle valve when the latter is only open slightly and the engine just idling over, then, as the suction behind the valve will be greater than that before the valve, the smaller inlet will supply the whole, or the major portion, of steam to make the correct amount of moisture with the small supply from the larger steam inlet. Upon opening the throttle more fully, the whole or greater percentage of moisture will be supplied before the throttle valve.—*December 15th*, 1934.



AERONAUTICS

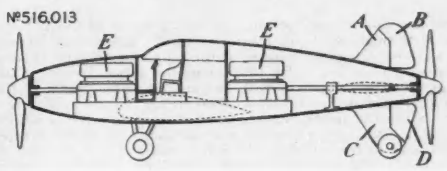
515,802. June 13th, 1938.—AUTOMATIC CONTROL OF AIRCRAFT, Siemens Apparate und Maschinen Gesellschaft mit beschränkter Haftung, Askanischer Platz 4, Berlin, S.W.11, Germany.

This invention concerns improvements relating to electrical follow-up devices for the automatic control of aircraft. Referring to the accompanying drawing, a direction indicator of any desired type (not shown) for example a directional gyroscope, controls a bridge circuit A in the current path of which a switching relay B loaded by a spring is connected. The spring is so adjusted that it retains the switching contact C in the mid-position between contacts D and E when the relay is unexcited, so that the current path extending to a control member F is interrupted. In the case of an automatic aircraft control the control member may be the rudder motor or an electric coupling arrangement for the rudder drive. The contact lever G of a potentiometer H is connected in series with the relay. The tapping J is the electrical mid-point of the potentiometer. When the direction indicator transmits a control "command" to the bridge, the balance thereof is changed and a movement of the relay is initiated. One of the contacts is thus closed and the control member is energised in one direction or the other. This control as described would give rise to hunting. A follow-up control must therefore be provided, which it will be presumed must function electrically. The contact lever is coupled in a manner known *per se* to the control member as indicated by the dotted line. The contact lever is thereby also displaced upon displacement of the control until the potential across the potentiometer is equal and opposite to the bridge potential. The two potentials then nullify one another, the relay becomes currentless and the contact closed by C is opened, so that the control member is switched off. The deviation of the lever G required for producing this effect is indicated by the angle X. As soon as the rudder has been deflected to the desired angle to compensate for the disturbance the potential across the bridge circuit is reduced to zero. Thus the aircraft resumes its normal course but an equal and opposite potential is developed across the bridge circuit which returns the rudder into the central position so as to maintain the normal course. The above described rigid arrangement can adequately control aircraft when influenced by a temporary disturbance but when subjected to a prolonged disturbance hunting will arise unless a resilient control device is provided. This is achieved by an electrical follow-up device a constructional example of which is given.—*December 14th*, 1939.



516,013. June 17th, 1938.—IMPROVEMENTS IN TWO-MOTORED AIRCRAFT, Dornier-Werke G.m.b.H., formerly known as Dornier-Metallbauten-G.m.b.H., and Dr. Ing. h.c. Claude Dornier, both of Friedrichshafen, Lake Constance, Germany.

The accompanying drawing shows diagrammatically and by way of example a two-motored aircraft in accordance with the invention. The fuselage carries a wing on each side, and at its rear end a tail unit. Whereas longitudinal control is effected by a stabiliser or tail plane with an elevator plane articulated to it of the usual design, the lateral control is effected by two tail fins, viz. a top fin A with a rudder or control surface B articulated to it, and a lower fin C with a control surface D articulated thereto. A pusher airscrew mounted at the rear necessitates the mounting of the tail wheel at a considerably

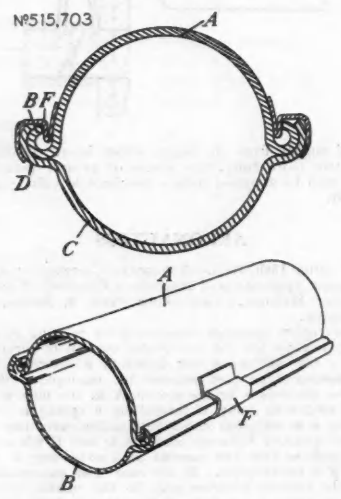


greater distance from the fuselage than is met with in other usual designs. The lower fixed fin acts at the same time as a suitable hood or cowling for the means supporting the tail wheel. Two identical engines, E, E are mounted within the fuselage. As they are mounted in reverse directions, and as their directions of rotation are therefore opposite, the moments of rotation are thus neutralised. The forward engine drives a tractor airscrew and the rearward a pusher airscrew mounted behind the tail unit.—*December 20th*, 1939.

TRANSMISSION OF POWER

515,703. June 9th, 1938.—PROTECTIVE CASINGS FOR ELECTRIC CABLES, Metal Trim, Ltd., Steleonite Works, Hayes, Middlesex, and Emil Penkala, of the same address.

In carrying the invention into effect according to one embodiment, one half section A of the casing is of semi-circular formation with the edges rolled over outwardly to form portions B the edges of which are spaced from the main part of the section while the other half section C, which is likewise of semi-circular formation, has its edge portions D bent outwards and shaped to a suitable curvature so as to embrace the rolled-over portions B when the sections are together. The outwardly bent and

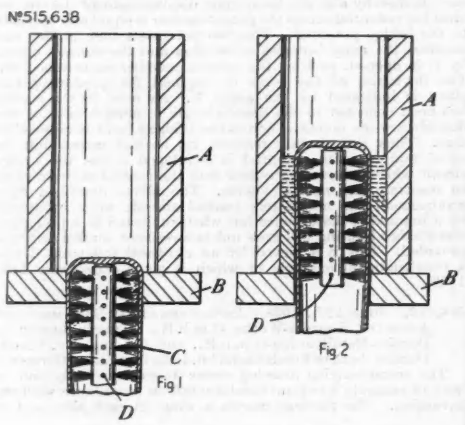


curved portions D extend beyond the transverse axis of the complete casing so that while they may be readily sprung or clipped over the rolled-over edges of the other half section they engage it firmly. In order to safeguard against accidental disengagement of the sections, spring clips F are applied at intervals, these clips having a folded portion adapted to seat in the space between the edge of the rolled-over edge portion and the wall of the section A and having an outwardly extending suitably bent portion adapted to engage over the outwardly bent and curved portion of the other half section.—*December 12th*, 1939.

METALLURGY

515,638. June 8th, 1938.—IMPROVEMENTS IN THE MANUFACTURE OF HOLLOW FORGINGS, Ernest Fraser Jones, Brook House, Walbrook, London, E.C.4.

In the drawing the mould consists of an upright hollow outer portion A. Its base B has a central aperture through which a hollow core C can be introduced from below. The aperture and the core are so designed as to correspond to the size of the interior of the metal hollow which is to be produced. Means are provided for raising the core slowly, at a rate corresponding to the rate at which metal can be poured into the mould. The interior of the core is provided with an air pipe D having cooling jets so that air or other cooling medium may be played upon it during the casting operation. In carrying the process into effect, commencing with the apparatus in the position illustrated in Fig 1, molten steel is poured into the mould at a uniform rate so that it descends at the side of the core. Simultaneously with the commencement of the pouring of the metal the plunger is slowly lifted. As the process proceeds the mould gradually fills with metal as shown in Fig. 2, and this metal

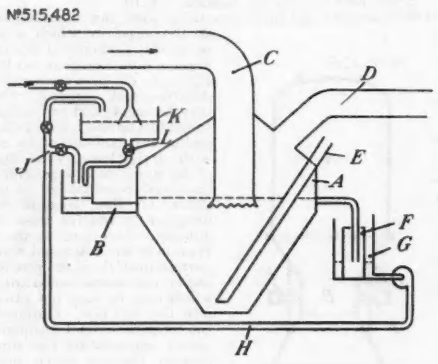


solidifies first at the bottom, the upper layers of metal being liquid throughout the pouring operation. The core is tapered so as to be of largest diameter at the top and somewhat smaller towards the bottom. By this means the upper portion of the core which is in contact with the molten metal preserves the internal diameter of the cast metal hollow at the appropriate size while the lower portion which is opposite the solidified metal in course of contraction is of sufficiently smaller diameter to be out of contact with the interior of the hollow which is produced. Thus undue friction is avoided in the movement of the core and its withdrawal is facilitated. At the conclusion of the pouring operation the core is withdrawn upwardly. If desired a thin metal casing may be carried on the core and carried by the core during the casting operation into the metal hollow and left there after the casting operation so as to form a lining therefor. Such a casing may be of a different material from the metal of the hollow, such as stainless steel, so as to produce a forging which has been lined with such material. *December 11th*, 1939.

MISCELLANEOUS

515,482. May 30th, 1938.—THE MANUFACTURE OF AMMONIUM SULPHATE, John Bell, Norton Hall, The Green, Norton-on-Tees, County Durham, and Imperial Chemical Industries, Ltd., Imperial Chemical House, Millbank, London, S.W.1.

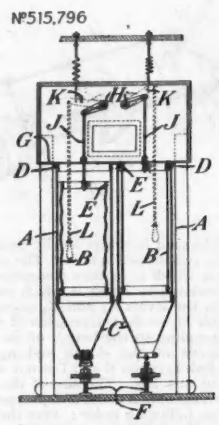
This invention relates to the manufacture of ammonium sulphate by the saturator process in which ammonia or ammonia-containing gas is passed into a bath containing a solution of ammonium sulphate and sulphuric acid. Referring to the drawing, A is the saturator, which is fed with mother liquor from tank B. The ammonia-containing gases are fed into the saturator through the pipe C and waste gases emerge through pipe D. The crystals of ammonium sulphate are deposited at the base of the saturator and are removed by means of the elevator E, after which they are drained and centrifuged, the mother liquor from these operations being returned to the saturator. The mother liquor also overflows from the saturator into a sealed pot F from the open top of which it overflows into the tank G. The liquor is pumped from this tank through the pipe



H to the junction J, from which it can be directed by manipulating valves either back into tank B where make-up acid can be added, or into the neutralising tank K. By adjustment of the valves it can be arranged that part of the mother liquor returns direct to tank B while simultaneously another part is diverted into the neutralising tank. Ammonia or ammonia-containing gas is introduced into tank K until the liquor is either neutral or alkaline. The liquid in the tank K is then permitted to come to rest, whereupon the impurities rise to the surface. These are removed by a ladle and the liquor is then discharged through valve L and returned to tank B in a purified condition. The quantity of mother liquor to be diverted will depend upon the amount of impurities it contains and the general conditions of working, but in any given case the required amount which results in the desired improvement in colour of the crystals can be readily determined by trial. In addition to improving the colour of the ammonium sulphate, the process has the advantage that pyridine originally present in the raw materials can conveniently be recovered from the layer of impurities removed from the treated liquor.—*December 6th*, 1939.

515,796. June 13th, 1938.—IMPROVEMENTS IN DRY DUST COLLECTORS, Geo. Adlam and Sons, Ltd., Fishponds, Bristol, Gloucestershire, Charles Herbert Griffiths, 67, Colston Avenue, Carshalton, Surrey, and E. R. and F. Turner, Ltd., Ipswich, Suffolk.

Dry dust collectors in which the air is blown by a fan into a series of textile collector bags have the disadvantage that before the container is full, the meshes of the collector bags have become clogged with dust and they have to be beaten to remove this accumulated dust, or the fan has to be stopped whilst the dirty collector bags are replaced by fresh ones. The object of this invention is the production of dry dust collectors in which the above disadvantage is obviated. Referring to the drawing, there are series of outer cylindrical fabric bags A and inner cylindrical fabric bags B and lower cylindrical fabric containers C. In any individual unit, bag A is fixed at the top to a metal ring D by a clip, and at the bottom by means of another clip Bag B is fixed at the top to a metal ring E, and at the bottom to a ring by another clip. The lower rings are fastened together



to form one component. Container C is fixed at its upper end by a clip ring in common with the lower end of bag A. At the lower end of the container is a plug around which it is gathered and held in position by band clip to which are attached two rings. Tension springs are attached at their upper ends to the rings and at their lower ends to screwed eye bolts. These eye bolts are fixed to tension rails and means for varying the tension on springs and consequently the tension upon outer bags and container is provided by screwed studs F. Over the top of all the units is a plate G to which are fixed the metal rings D. In the plate are apertures corresponding in number and diameter to the inner bags. Above the plate is formed a dust receiving chamber or box into which is delivered the dustladen air. In the dust receiving chamber is a shaft or shafts running longitudinally, to which are attached arms, and from these arms extend vertical rods J, the lower ends of which are fixed to the ring E of the inner bag. Upon the exterior extensions of shafts H at one end are fixed arms K to which are attached spring loaded rods and handles L of suitable length. In operation to prevent the mesh of the inner bags becoming clogged with the finer dust and the consequential prevention of the air passing through to the outer bags, a pull on the handle L lowers the inner bags in concertina fashion as shown in the left in the drawing, and upon release of the handle tension springs quickly lift the bags back up to the original working position. The shaking apparatus can be arranged to shake a whole row of bags or part of a row, as desired.—*December 16th*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Bradford Engineering Society

Monday, March 4th.—Technical College, Bradford. "The Operation, Development, and Maintenance of Automobile Electrical Equipment," W. Marshall. 7.30 p.m.

Institution of Automobile Engineers

Tuesday, March 12th.—Coventry Centre. Kings Head Hotel, Coventry. "Modern Applications of Cast Iron in Automobile Construction," E. C. Toghill and R. Dowle. 7 p.m. Luton Centre. George Hotel, Luton. "A Few Odd Notes on Engines," A. Taub. 7.30 p.m.

Wednesday, March 13th.—Manchester Centre. Engineers' Club, Albert Square, Manchester. "Alternative Fuels for C.I. Engines," W. Allen. 7.15 p.m.

Monday, March 18th. Glasgow Centre. Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. "Exhaust Systems for 4- and 6-cylinder Engines," J. C. Morrison. 7.30 p.m.

Tuesday, March 19th.—Birmingham Centre. James Watt Memorial Hall, Birmingham. Symposium on Deep Drawing Research. 7 p.m.

Wednesday, March 20th.—Leeds Centre. Metropole Hotel, Leeds. "The Theory of Flexible Mountings for Internal Combustion Engines," C. B. Iliffe. 6 p.m.

Institution of Civil Engineers

Tuesday, March 5th.—Great George Street, Westminster, S.W.1. "The Construction of Deep-Water Quays," A. C. Gardner. 5.30 p.m.

Institution of Electrical Engineers

To-day, March 1st.—N.E. Students. Newe House, Pilgrim Street, Newcastle-upon-Tyne. "Switchgear Design," D. H. Towns. 7 p.m.

To-day, March 1st.—Meter and Instrument Section. Savoy Place, Victoria Embankment, W.C.2. "A Method of Measuring and Recording the Frequency Error of A.C. Power Supplies," F. O. Morrell. 6 p.m.

Wednesday, March 6th.—Wireless Section. Savoy Place, Victoria Embankment, W.C.2. "Wire Broadcasting Investigations at Audio and Carrier Frequencies," T. Walmsley. 6 p.m.

Thursday, March 7th.—Savoy Place, Victoria Embankment, W.C.2. "Oil-less Metal-clad Switchgearf or Medium-Voltage A.C. Circuits up to 660 volts, Three-phase," H. E. Cox and L. Drucquer. 6 p.m.

Monday, March 11th.—Savoy Place, Victoria Embankment, W.C.2. Joint Meeting with Inst. C.E. and Inst. Mech. E. "Emergency Repairs, with Special Reference to Welding." 6 p.m.

Friday, March 15th.—Savoy Place, Victoria Embankment, W.C.2. Informal Discussions "Cathode-Ray and Duddell Type Oscillographs," J. T. MacGregor Morris, and "What are the Practical Limits of Error in A.C. House Service Meters and in Sub-Standard Watt Meters," A. J. Pitt. 6 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, March 19th.—39, Elmbank Crescent, Glasgow, C.2. "A Modern Approach to Building Technique," A. Miller. 6.30 p.m.

Institution of Mechanical Engineers

To-day, March 1st.—Storey's Gate, Westminster, S.W.1. "The Circulation of Water and Steam in Water-Tube Boilers, and the Rational Simplification of Boiler Design," W. Yorath Lewis and S. A. Robertson. 6 p.m.

Friday, March 15th.—Storey's Gate, Westminster, S.W.1. Lowe Gray Lecture, "Fifty Years of Marine Engineering," A. L. Mellanby. 6 p.m.

Institution of Naval Architects

Wednesday, March 13th.—Royal Society of Arts, John Street, Adelphi, W.C.2. Annual Meeting.

Institution of Production Engineers

Tuesday, March 12th.—Birmingham Graduates. James Watt Memorial Institute, Birmingham. "Modern Fabrication by Arc Welding," H. W. Hawkins. 7 p.m.

Junior Institution of Engineers

To-day, March 1st.—Sheffield Metallurgical Club, West Street, Sheffield. "Mechanical Properties in Relation to Design," H. W. Swift. 7.30 p.m.

Manchester Association of Engineers

Friday, March 8th.—Grand Hotel (Jubilee Suite), Aytoun Street, Manchester. Dinner and Dance. 7 for 7.30 p.m.

Newcomen Society

Wednesday, March 13th.—Institution of Civl Engineers, Great George Street, S.W.1. "Electrical Invention and Re-Invention," W. T. O'Dea, and "Amedee Bollee—Pioneer of Mechanical Road Locomotion," J. R. Nichols. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, March 8th.—Mining Institute, Newcastle-upon-Tyne. "Mean Pitch Determination of Variable Pitch Propeller," E.V. Telfer. 6 p.m.

Royal Aeronautical Society

Tuesday, March 12th.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Aircraft Production," H. J. Pollard. 6 p.m.

Royal Institution of Great Britain

Monday, March 4th.—21, Albemarle Street, W.1. General Meeting. 3 p.m.

Wednesday, March 6th.—21, Albemarle Street, W.1. "X-Ray Optics," W. L. Bragg. 5.15 p.m.

Friday, March 8th.—21, Albemarle Street, W.1. "Experiments from the Researches of Sir James Dewar," Sir William Bragg. 5 p.m.